PB-218 086

PATUXENT RIVER CROSS SECTIONS AND MASS TRAVEL VELOCITIES

Federal Water Pollution Control Administration
Annapolis, Maryland

July 1968

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PB 218 086

DATA REPORT

PATUXENT RIVER

Cross Sections

and

Mass Travel Velocities

NATIONAL TECHNICAL
INFORMATION SERVICE

Chesapeake Field Station
FWPCA
Middle Atlantic Region
July 1968

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I. INTRODUCTION

A. Survey Description

The Chesapeake Field Station, FWPCA, conducted field surveys from 1966 to 1968 to obtain cross-section measurements and mass travel velocities in the Patuxent River and Little Patuxent River. Cross-section surveys were conducted on the tidal river between Jones Point (River Mile 36.8) which is the upper limit of hydrographic information on the USGS 7 1/2 minute (scale 1:24,000) quadrangles, and RM 53.4, which is near the head of tide. In this reach cross-sections were measured at 0.2 mile intervals.

Cross-section and dye travel surveys were conducted on selected reaches of the Patuxent River near and downstream from the Baltimore-Washington Parkway, near Montpelier, Md., (RM 73.4) and on selected reaches of the Little Patuxent River near and downstream from US Route 1, (RM 81.0). A basin map is shown in Figure 1. River mile zero is at the mouth of the tidal river near Solomon's, Md.

B. Purpose and Authority

These field activities were undertaken to provide information about physical characteristics of the river for use in computing the effects of waste discharges on the river. The survey was conducted and this report prepared under the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et. seq.) which directed the Secretary of the Interior to develop programs for eliminating pollution of interstate waters and improving the sanitary conditions of surface and underground waters.

II. METHODS AND PROCEDURES

A. Cross-section Measurements

1. Field procedures

In the non-tidal reaches, where the river is quite narrow, widths were usually measured using a marked rope. An *optical rangefinder with a range of 8 - 100 feet was also used. The river was crossed both by wading and by boat. Depths were measured at transverse stations with a marked staff.

In the tidal reaches, somewhat more elaborate procedures were necessary. The water was always deep enough to require a boat. Depths were determined using a portable battery-operated, pointer-indicating, non-recording depth finder. The transducer foot was at first held over the side by hand; later a clamp was used to hold it to the gunwale of the skiff. The **instrument used indicated depths on 0 - 12 and 0 - 120 foot scales. The range selection, an unusual feature, reduces the loss in precision encountered in sound shallow water with a depth finder designed for use in water more than a hundred feet deep.

River widths varied from about 100 to nearly 1,000 feet. Narrower sections were measured using a 300-ft. marked steel-cable tagline of the Lee-Au type. The line was anchored or tied at one end, and then carried

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*Edmund Scientific Co. 6 inch rangefinder. This instrument was of limited usefulness for large river work because of its short range. In other respects it was satisfactory. (See disclaimer below.)

**Ray Jefferson Model 400. (See disclaimer below.)

Disclaimer: Mention of equipment items by manufacturer or mention of specific features of said equipment does not constitute endorsement by FWPCA.

across the river and held fast. A second boat was used to measure depths at the transverse stations.

The widths of a majority of the wider sections were measured using the following procedure: The boat was steered directly across the river running at a uniform speed. Depths were read at uniform time intervals (usually 10 seconds) measured by a watch with a sweep-second hand. The exact location of the section was noted, and the width in feet was later estimated from topographic maps. The measured depths were then pro-rated in the cross-section by dividing the width into equal segments so the number of segments agreed with the number of depths. Cross-sections so obtained are marked "time sections". The tagline was occasionally used in conjunction with the optical rangefinder to measure widths of more than 300 feet.

2. Computations

Bottom profiles were plotted from measured depths and transverse distances. These graphs are shown in Sections III-C and III-D of this report for the tidal and non-tidal reaches respectively, in river mile order beginning at the downstream limit of the survey. The vertical axis of the graphs is measured depth, with the observed water surface at zero. A second horizontal line representing the water surface at mean low water (MLW) appears on the cross-section plots for the tidal river. This graphical adjustment is necessary to obtain depths and cross-sectional areas at a common tidal height condition. Areas indicated on the cross-section graphs for the tidal river are those cross-sectional areas below MLW. Graphs of cross-sectional area versus river mile are shown in Section III-A.

Cross-sectional areas were measured using a *compensating polar planimeter.

In order to estimate the variation of the actual tidal heights as influenced by wind from the **heights due to the astronomical tides, a measurement was made from an arbitrary temporary reference point (RP) to the water surface preceding and following each day's cross-section measurements. The RP was located at Hill's Bridge, the crossing of Md. Route 4, near Wayson's Corner. The elevation of the RP was related to the elevation of MLW by measuring down on the bulkhead to the high water mark. The high water mark was assumed to lie above MLW by 2.4 ft., a distance equal to the mean tidal range. Observed and predicted tidal heights are listed in Table 1 as variations from MLW.

The procedure outlined gave the actual tidal heights at the beginning and end of each day's surveying period at Hill's Bridge only. Locations downstream were referred to the Hills Bridge measurements by assuming (a) that the wind produced a uniform change in mean tidal height in the reach between ***Hill's Bridge and Nottingham (RM 38.4, near Jones Point) over the time involved in making each day's cross-section measurements; and (b) that the astronomical tides would be superimposed on the longer-

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*Keuffel and Esser Model 62 0000. (See disclaimer page 2.)

**as indicated by the predicted heights in the US Coast and Geodetic Survey Tide Tables, 1968.

***Hill's Bridge and Nottingham are "subordinate tidal stations", at which predictions can be obtained by difference from a reference station (Baltimore). Tidal heights are not recorded at most subordinate stations.

Table 1

TIDAL HEIGHTS AT HILL'S BRIDGE

Date (1968)	Time (0-2400)	Tidal Height (Ft. above MLW) Observed	Predicted
Feb. 29	1010	-0.9	+0.6
	1330	-1.2	-0.2
Mar. 7	0930	+1.6	+0.3
	1425	+0.6	+1.8
Mar. 8	1030	+1.8	+2.1
	1510	+1.2	+1.4
Mar. 11	1030	+0.3	+2.2
	1530	+2.0	-0.1
Mar. 20	1510	+1.1	+1.4
Mar. 21	1000	+1.9	+2.4
	1530	+0.5	+1.3
Mar. 22	1030	+1.8	+1.4
	1530	+1.2	+4.4
Mar. 25	1000	-1.3	-0.4
	1530	-1.4	+4.8
Mar. 26	1030	-0.4	-0.4
	1430	+1.6	+5.1
Mar. 29	1100	-0.4	-0.2
	1530	+1.4	+5.4
Apr. 2	1000	-0.1	+4.4
	1410	-0.2	+1.4

period tidal height variations produced by wind.

Under these assumptions, actual tidal heights at Nottingham were estimated by adding or subtracting the differences in predicted (astronomical) tidal heights between Hill's Bridge and Nottingham to the actual heights measured at Hill's Bridge. The tidal heights at the beginning and end of each day's surveying were interpolated linearly with distance between Hill's Bridge and Nottingham. The changes in tidal height with time over the reach covered that day could then be estimated.

Locations upstream from Hill's Bridge were referred to the Hill's Bridge measurements under the assumption that tidal action stopped at the upper limit of the tidewater survey (RM 53.4). Differences in the observed tidal heights preceeding and following each day's surveying were decreased to zero linearly with distance between Hill's Bridge and RM 53.4. Variations with time over the day's surveyed reach were then estimated. Cross-sections in the extreme upper tidal reaches probably vary as much with streamflow as with tide. Streamflow may exert an appreciable effect on cross-sectional area as far downstream as RM 49, where the tidal river begins to enlarge greatly.

For the non-tidal river, where depth and cross-sectional area vary with river discharge, the cross-sectional areas were computed from cross-section graphs plotted exactly as measured. Areas of these sections must therefore be related to the river discharge at which they were taken. The variation of depth and cross-sectional area with flow is discussed in Section III-C.

B. Dye Travel Velocity Measurement

The time-of-travel of the water mass was measured from one to three times in four stream reaches, each of which contained a US Geological Survey *temporary gaging station. The USGS had also previously conducted a time-of-travel survey covering these four plus two additional reaches, both of which included gages. Gaging station locations and the number of time-of-travel measurements in each reach are indicated in Table 1.

Time of travel was determined by introducing Rhodamine B dye into the water and detecting it later at a point downstream. A Turner** was used to detect the dye. Samples were taken at ten-minute intervals so that the peak concentration could be easily distinguished. The elapsed time between time of release and the time of peak, and the distance between the release and sampling points were used to determine an average mass travel velocity over the reach. All time-of-travel measurements were conducted during periods of steady flow. Dye velocities so obtained are indicated on graphs of discharge versus velocity in Section III-B.

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C. Variations of Depth and Velocity With River Discharge

The logarithms of depth and velocity were plotted against the logarithms of river discharge for the six gaging stations in the survey area, using average depths and average velocities from the USGS discharge measurements. The resulting graphs are shown in Section III-B.

Logarithms of dye velocities obtained from tracer studies were also plotted versus the logarithms of river discharge. Dye velocities

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* These stations consist of reference points to establish water surface elevations at river locations at which the stage-discharge relation has been established. Terminology does not refer to short-term installation of a recording gage.

** Turner Model III (See disclaimer Page 2).

Table 2

GAGING STATION DESCRIPTIONS

Station	Type of Gage	River Mile	Time of Travel Studies
Patuxent River at Montpelier	Wire-weight (Temporary)	75.0	CRS 1X USGS 1X
Patuxent River at Pigeon House Corner	Wire-weight (Temporary)	63.7	CRS 2X USGS 1X
Patuxent River at John Hansen's Hwy	Wire-weight (Temporary)	60.7	CRS 1X USGS 1X
Patuxent River at Hardesty	Reference Pt. on Bridge (Temporary)	54.9	CRS 3X USGS 1X
Little Patuxent River at Savage II	- (Temporary)	81.5	USGS 1X
Little Patuxent River at Station L-1	Staff (Temporary)	63.8	USGS 1X

formed straight lines parallel to but at lower value than the average velocities from discharge. The parallel orientation of the "velocity" and "velocity adjusted" lines has been found to be a generally valid relationship. The "velocity adjusted" line can be used to find the mean travel velocities at various discharges.

The "depths" line can be used to translate depths and cross-sectional areas to stream flow conditions other than those at which the cross-sections were measured. Reasonable accuracy should be maintained in cross-sectional areas as long as the river stage does not exceed bank-full conditions.

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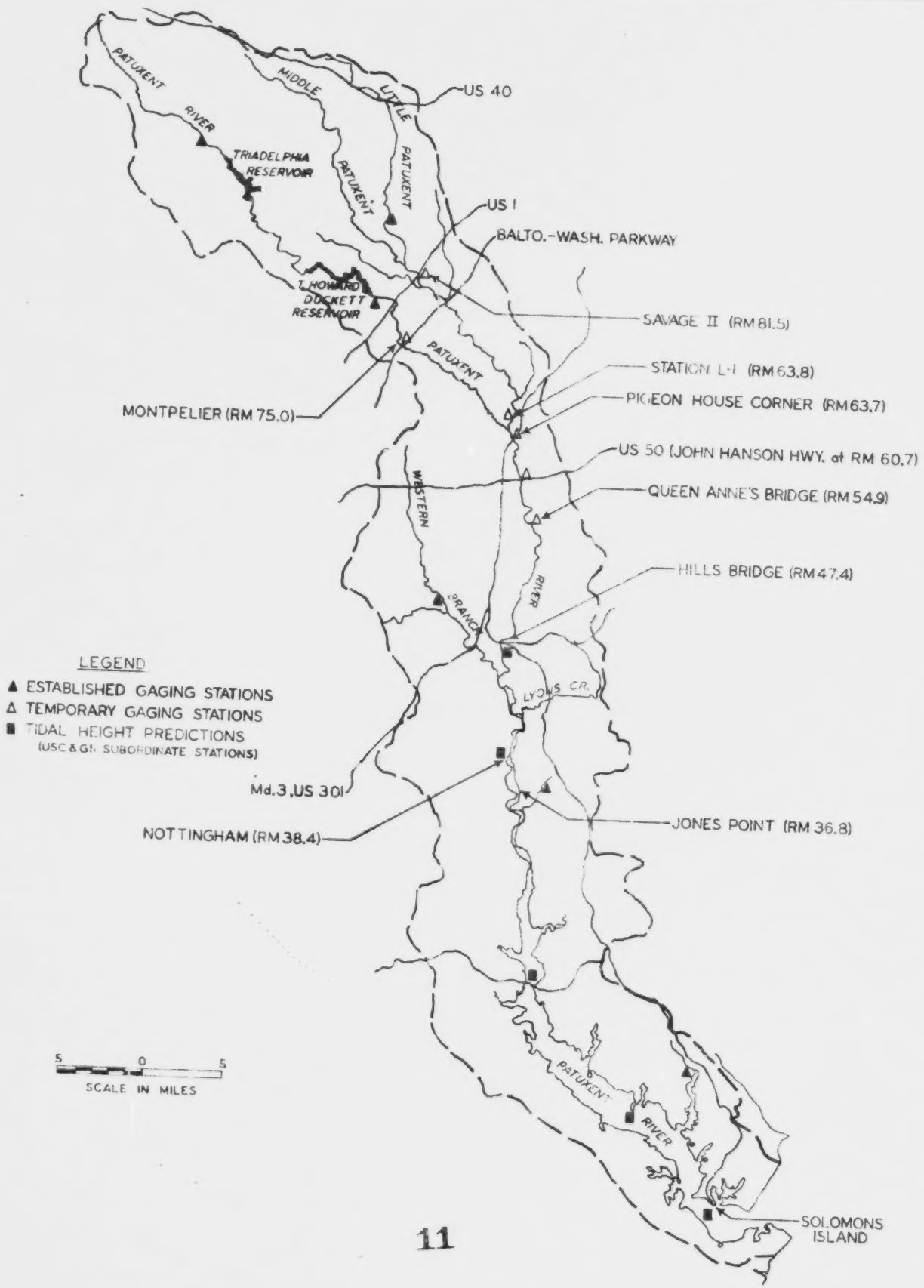
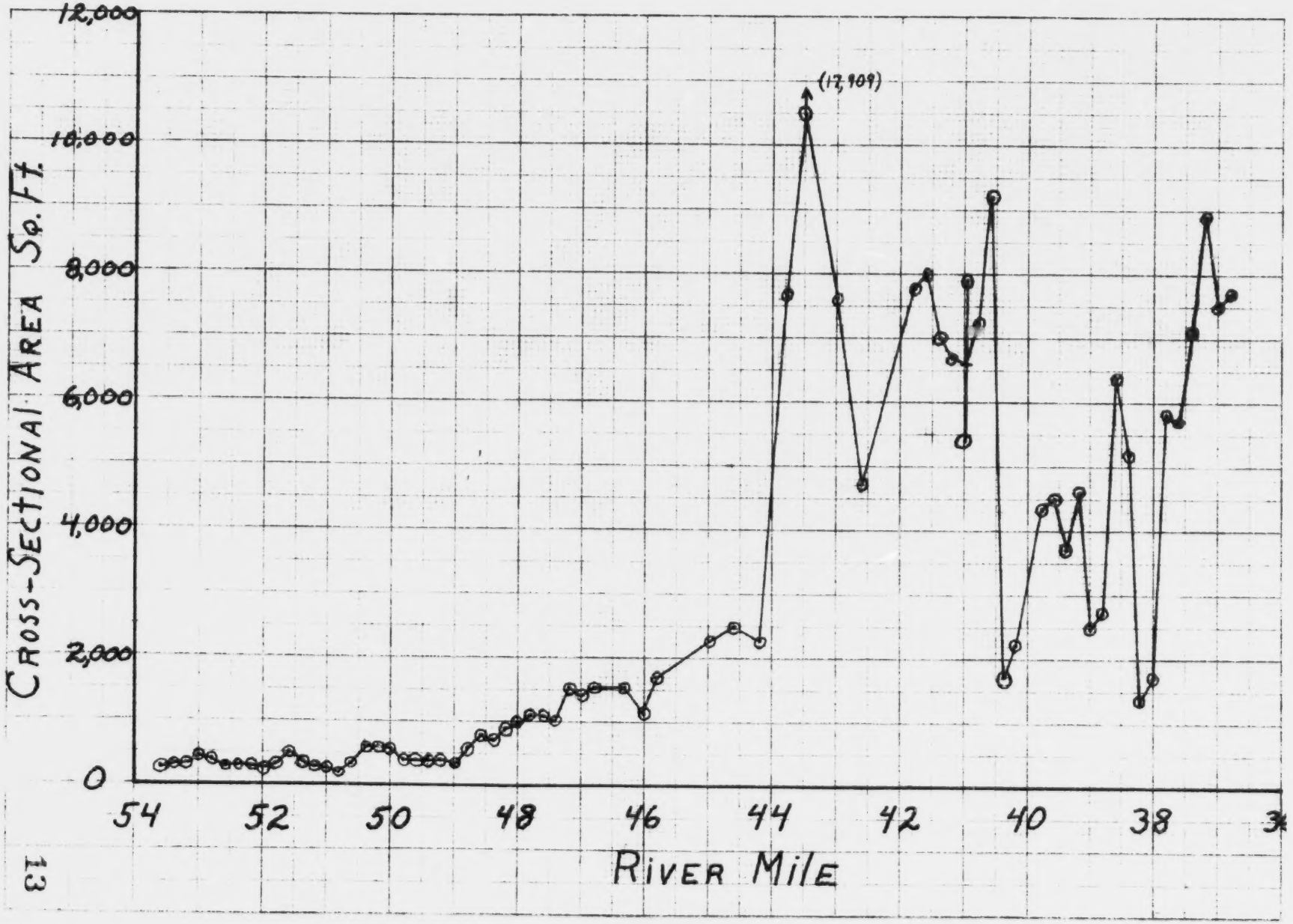

PATUXENT RIVER
MIDDLE PATUXENT
LITTLE PATUXENT
TRIADELPHIA RESERVOIR
T. HOWARD DUCKETT RESERVOIR
US 40
US 1
BALTO.-WASH. PARKWAY
SAVAGE II (RM 81.5)
STATION L-1 (RM 63.8)
PIGEON HOUSE CORNER (RM 63.7)
US 50 (JOHN HANSON HWY. at RM 60.7)
QUEEN ANNE'S BRIDGE (RM 54.9)
HILLS BRIDGE (RM 47.4)
MONTPELIER (RM 75.0)
WESTERN BRANCH
RIVER
LYONS CR.
Md. 3, US 301
NOTTINGHAM (RM 38.4)
JONES POINT (RM 36.8)
PATUXENT RIVER
SOLOMONS ISLAND
LEGEND
▲ ESTABLISHED GAGING STATIONS
△ TEMPORARY GAGING STATIONS
■ TIDAL HEIGHT PREDICTIONS
(USC & GS SUBORDINATE STATIONS)
5 0 5
SCALE IN MILES

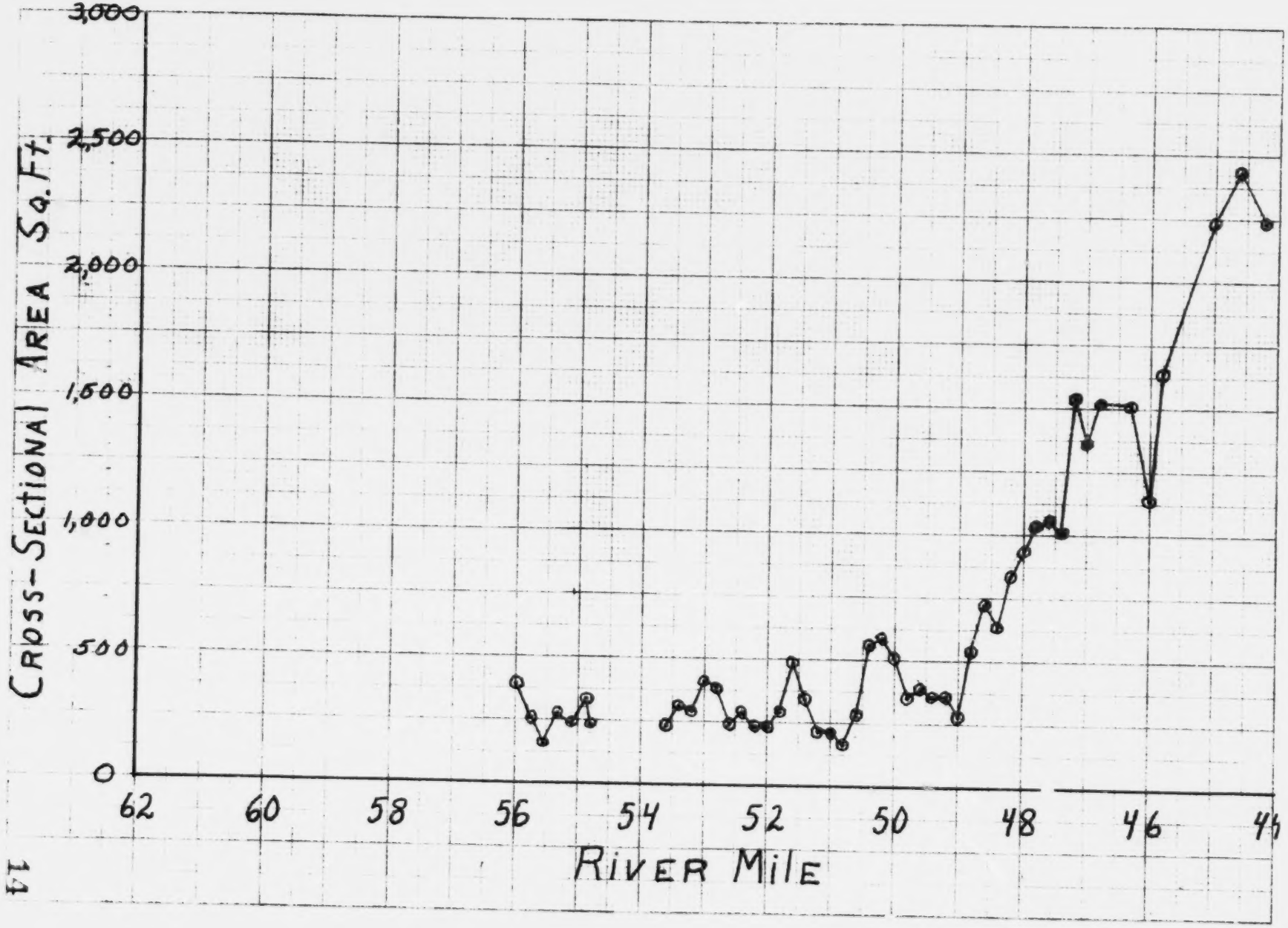
FIGURE 1

III - A. CROSS-SECTIONAL AREAS OF THE TIDAL RIVER VERSUS RIVER MILE

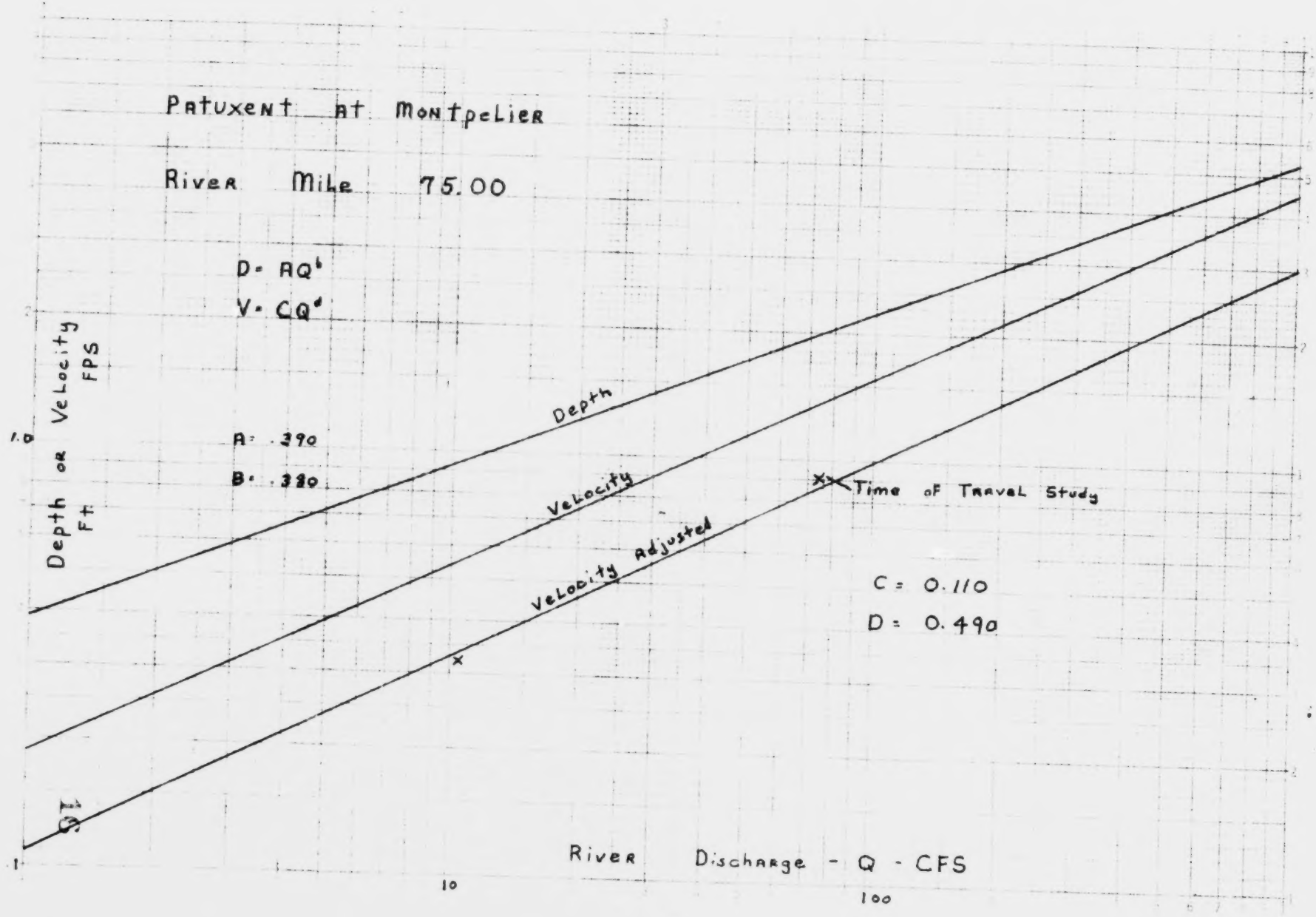
K+E 20 X 20 TO THE INCH 46 1242

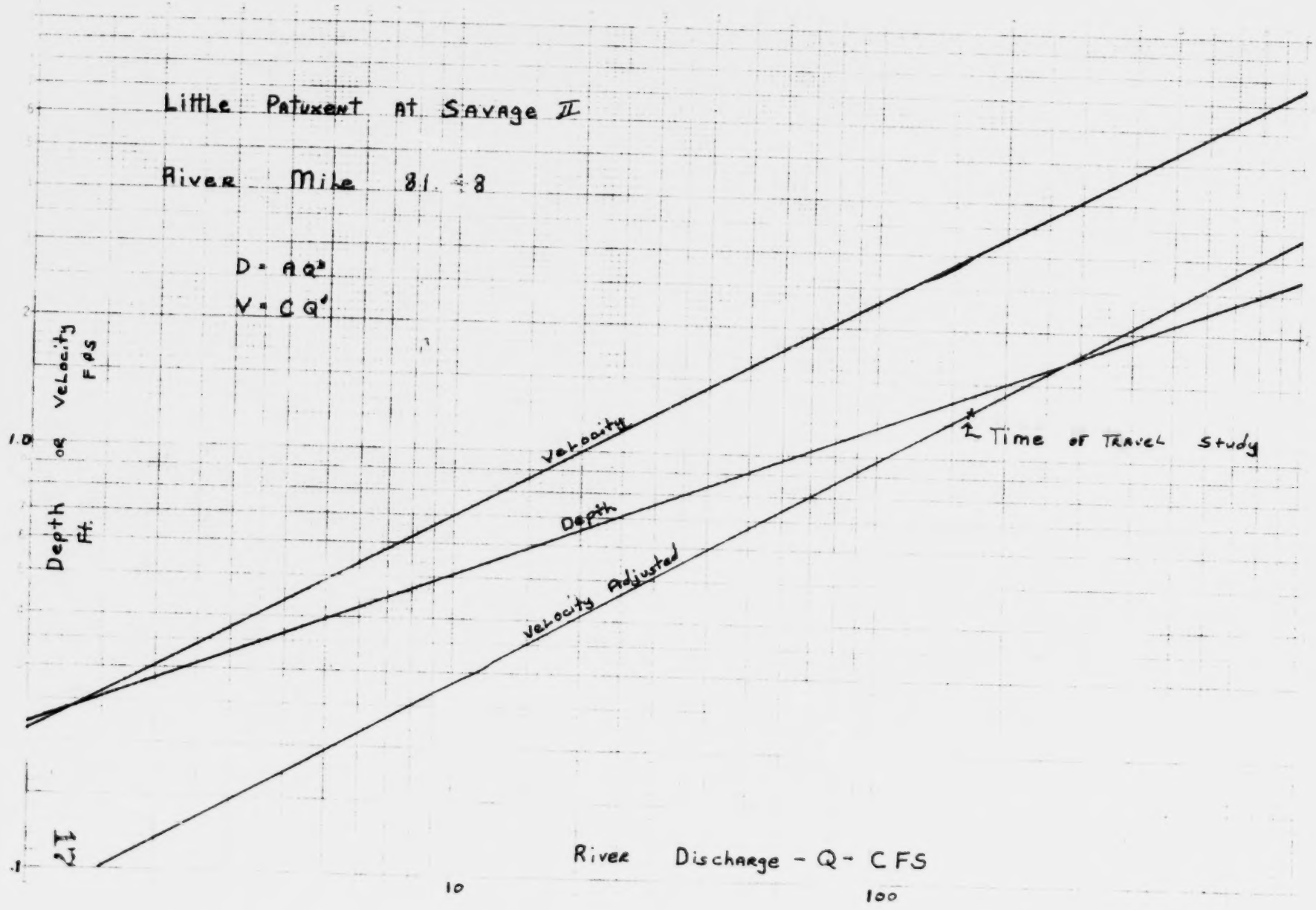


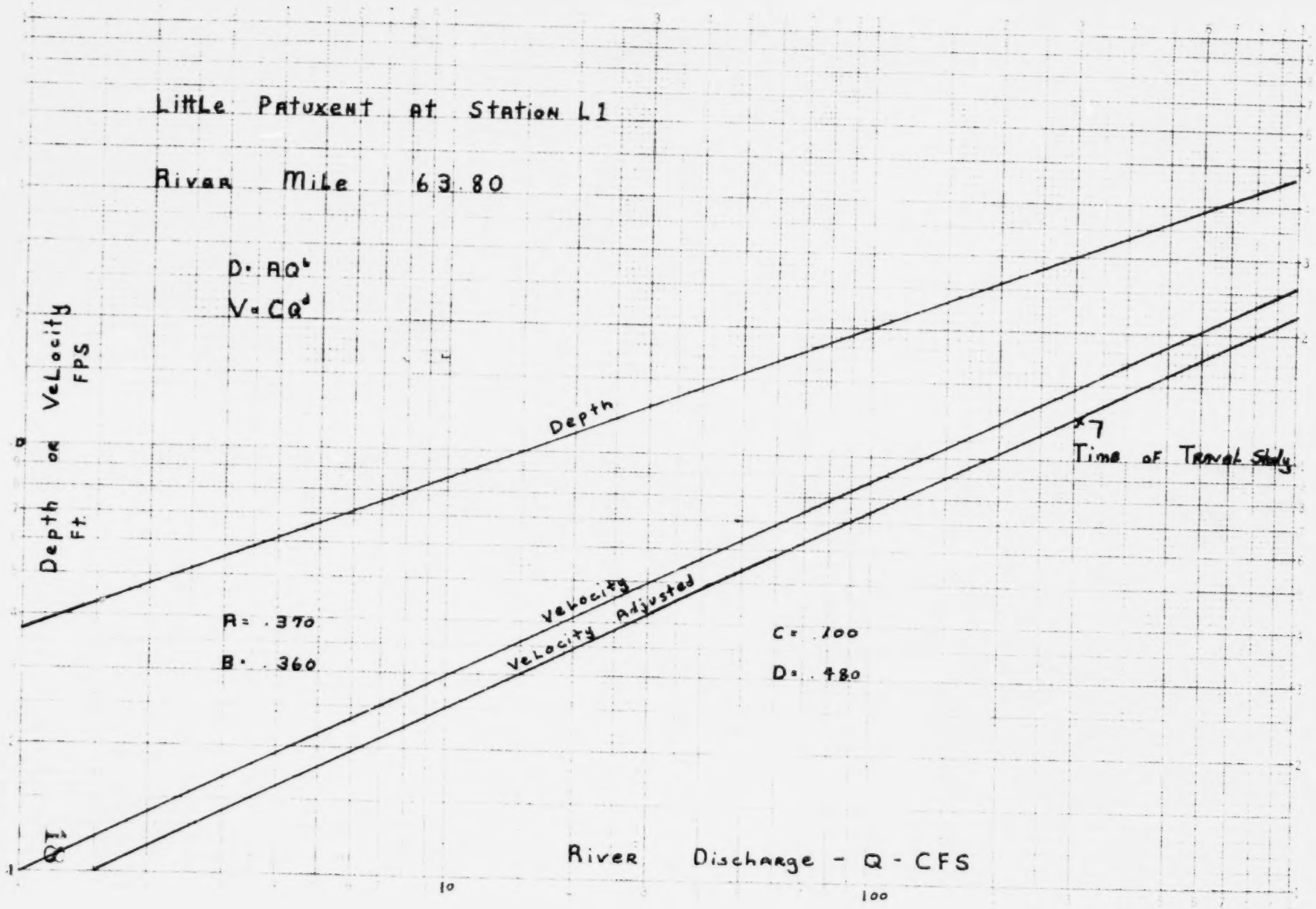
K&E 20 X 20 TO THE INCH 46 1242



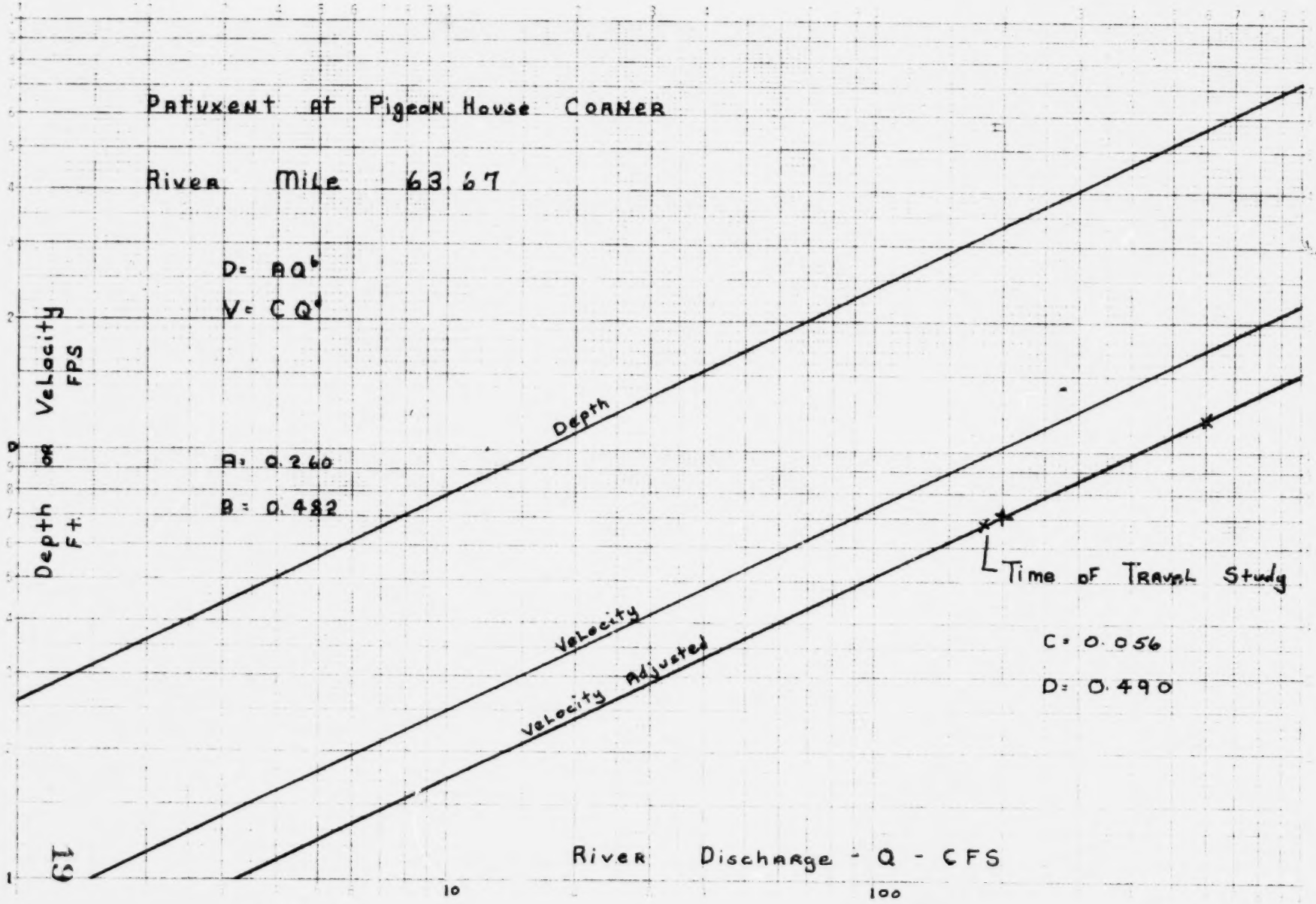
III - B. DEPTH, VELOCITY AND VELOCITY ADJUSTED VERSUS RIVER DISCHARGE

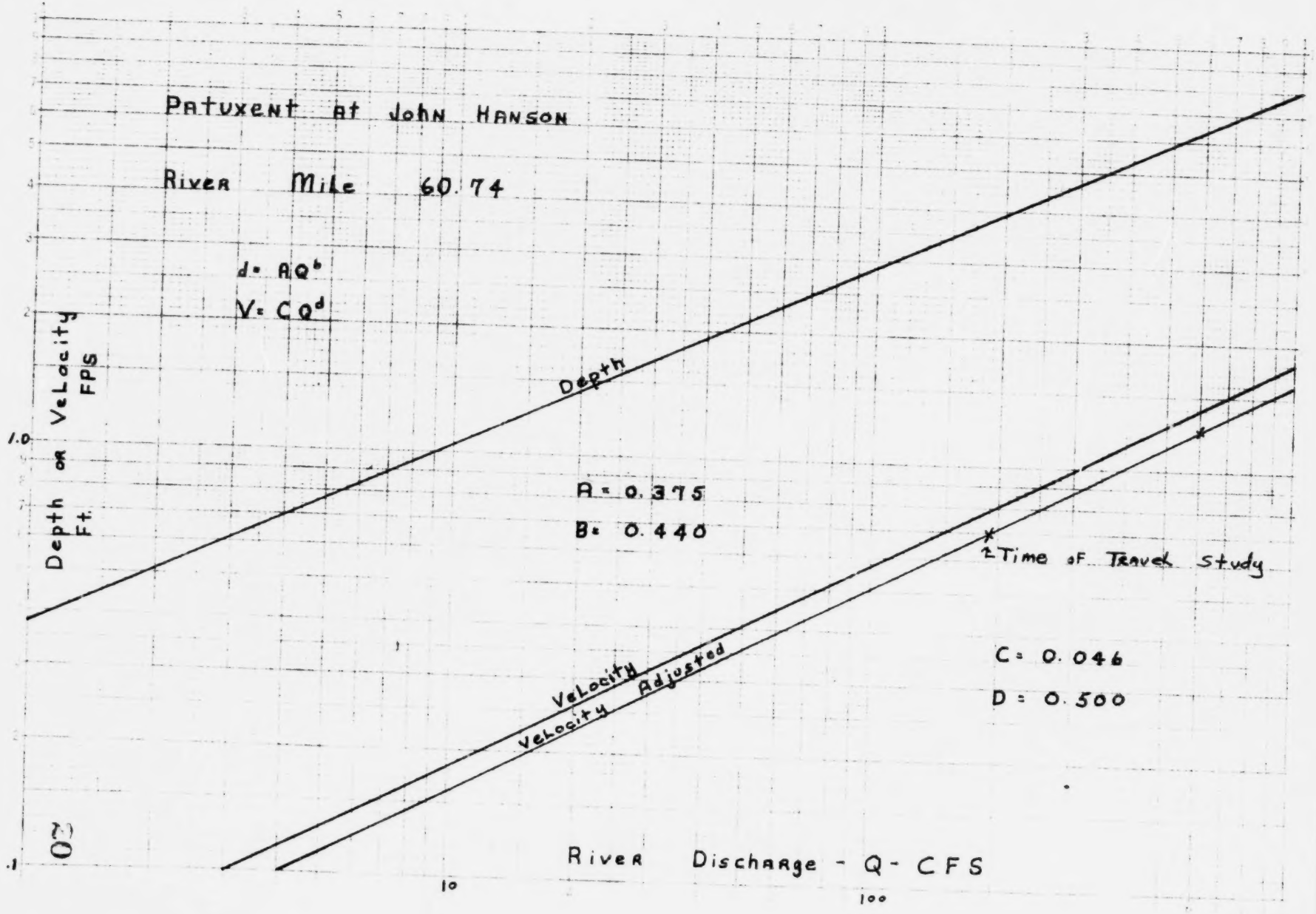

Patuxent at Montpelier
River Mile 75.00
D = AQ^b
V = CQ^d
A = .390
B = .330
C = 0.110
D = 0.490
Depth
Velocity
Velocity Adjusted
Time of Travel Study
Depth or Velocity FPS
River Discharge - Q - CFS
1.0
1
10
100

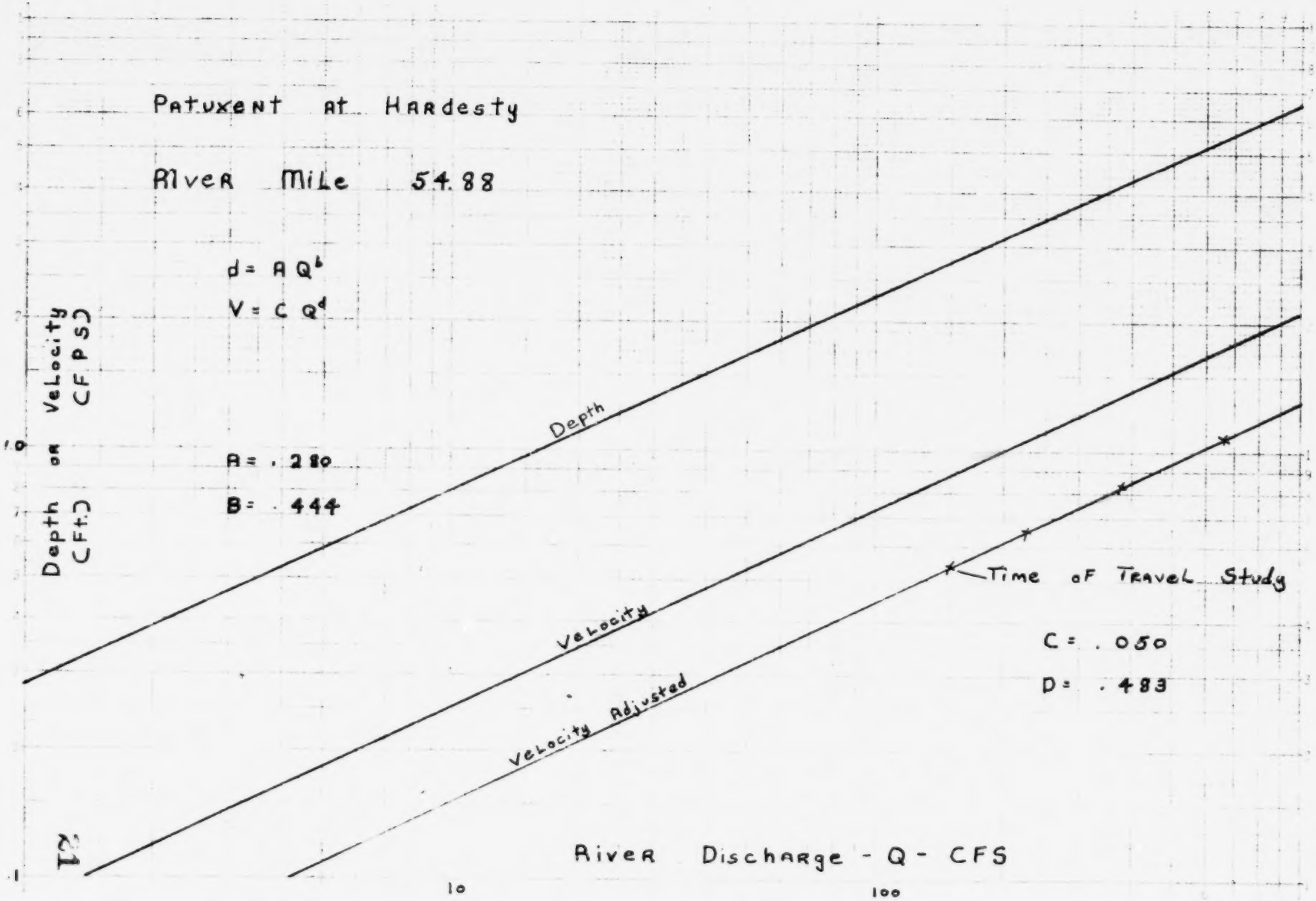

Little Patuxent at Savage II
River Mile 8.1 - 8
D = aQ^b
V = cQ^f
Depth or Velocity FPS
Depth Ft.
Velocity
Depth
Velocity Adjusted
Time of Travel Study
River Discharge - Q - CFS
1.0
2
10
100


Little Patuxent at Station L1
River Mile 63.80
D = AQ^b
V = CQ^d
Depth or Velocity FPS
Depth
Velocity
Velocity Adjusted
x7
Time of Travel Study
A = .370
B = .360
C = 100
D = .480
River Discharge - Q - CFS
10
100

46 7320 LOGARITHMIC

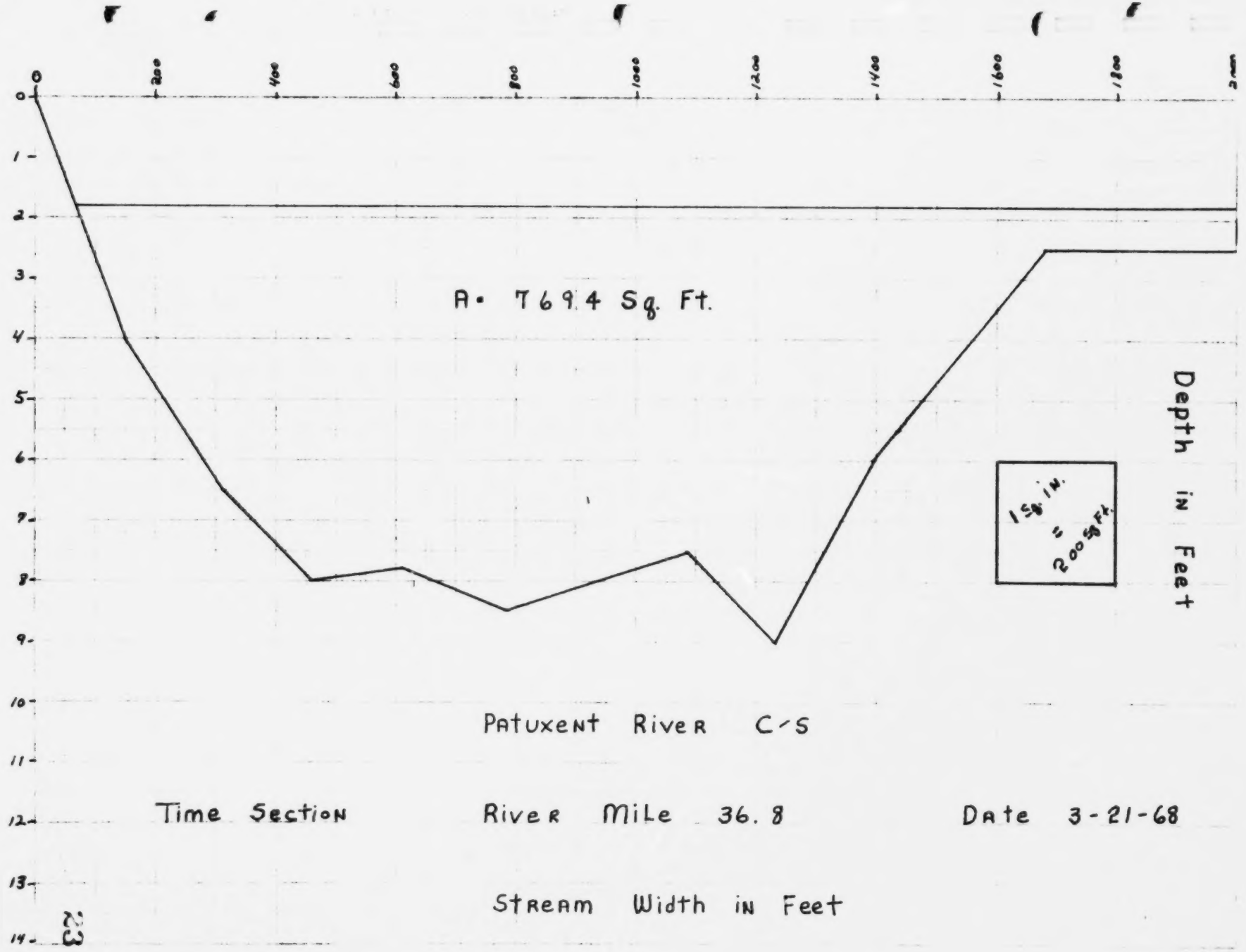


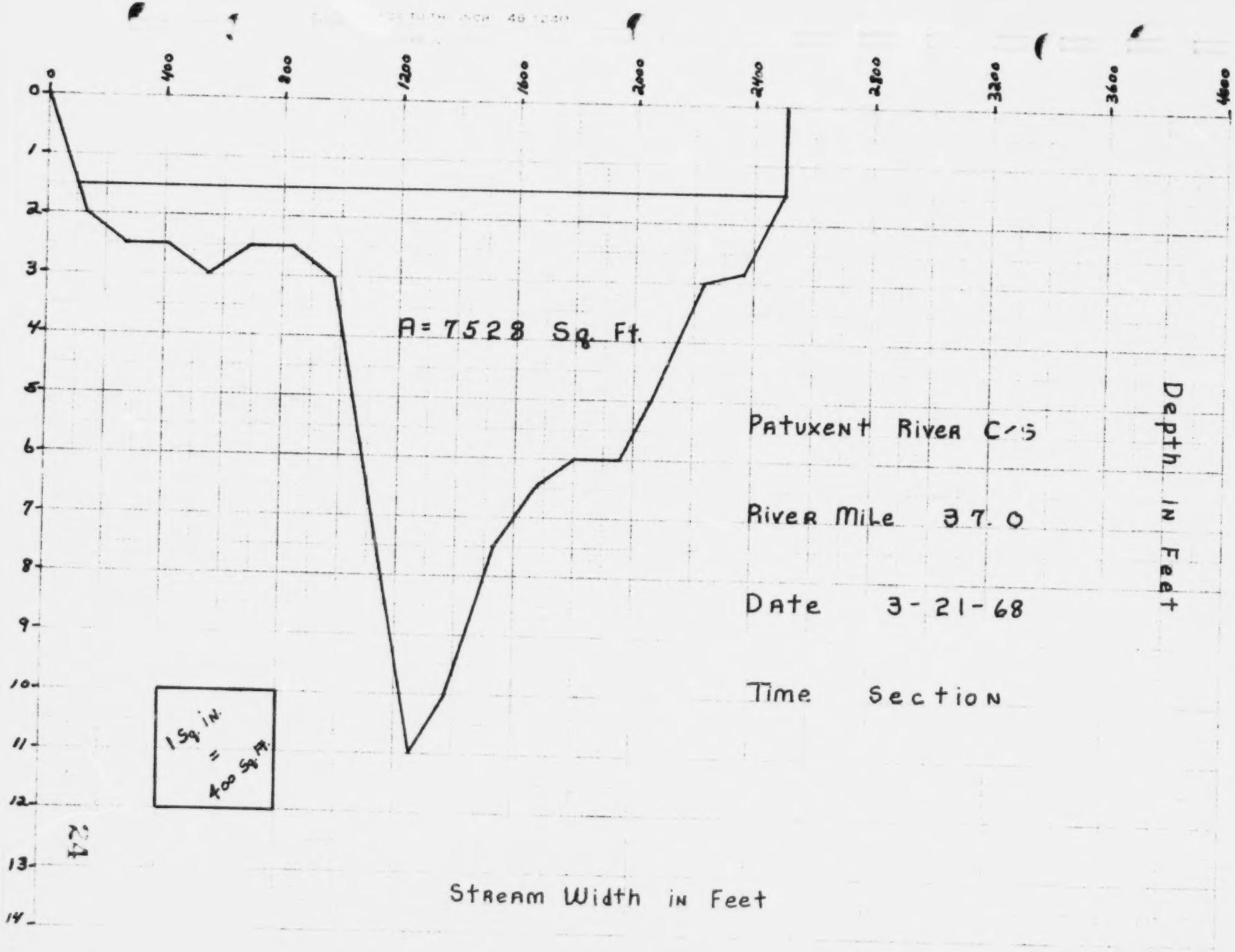

Patuxent at John Hanson
River Mile 60.74
d = aQ^b
V = cQ^d
Depth
Velocity
Velocity Adjusted
Depth or Velocity FPS
Ft.
A = 0.375
B = 0.440
C = 0.046
D = 0.500
Time of Travel Study
River Discharge - Q - CFS
1.0
.1
10
100

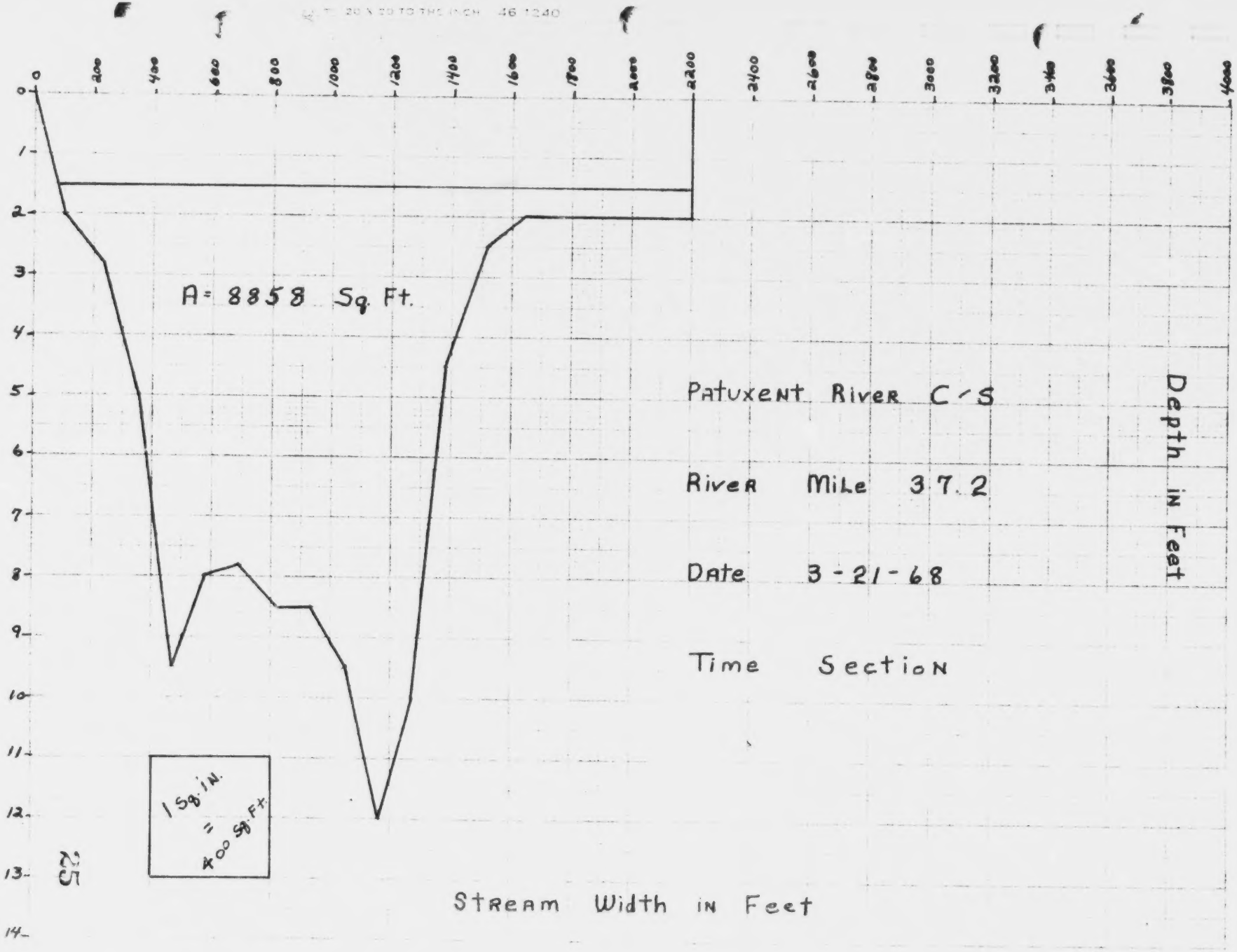

Patuxent at Hardesty
River Mile 54.88
d = A Q^b
V = C Q^d
A = .280
B = .444
C = .050
D = .483
Depth
Velocity
Velocity Adjusted
Time of Travel Study
Depth or Velocity (CFPS)
River Discharge - Q - CFS
10
100
1

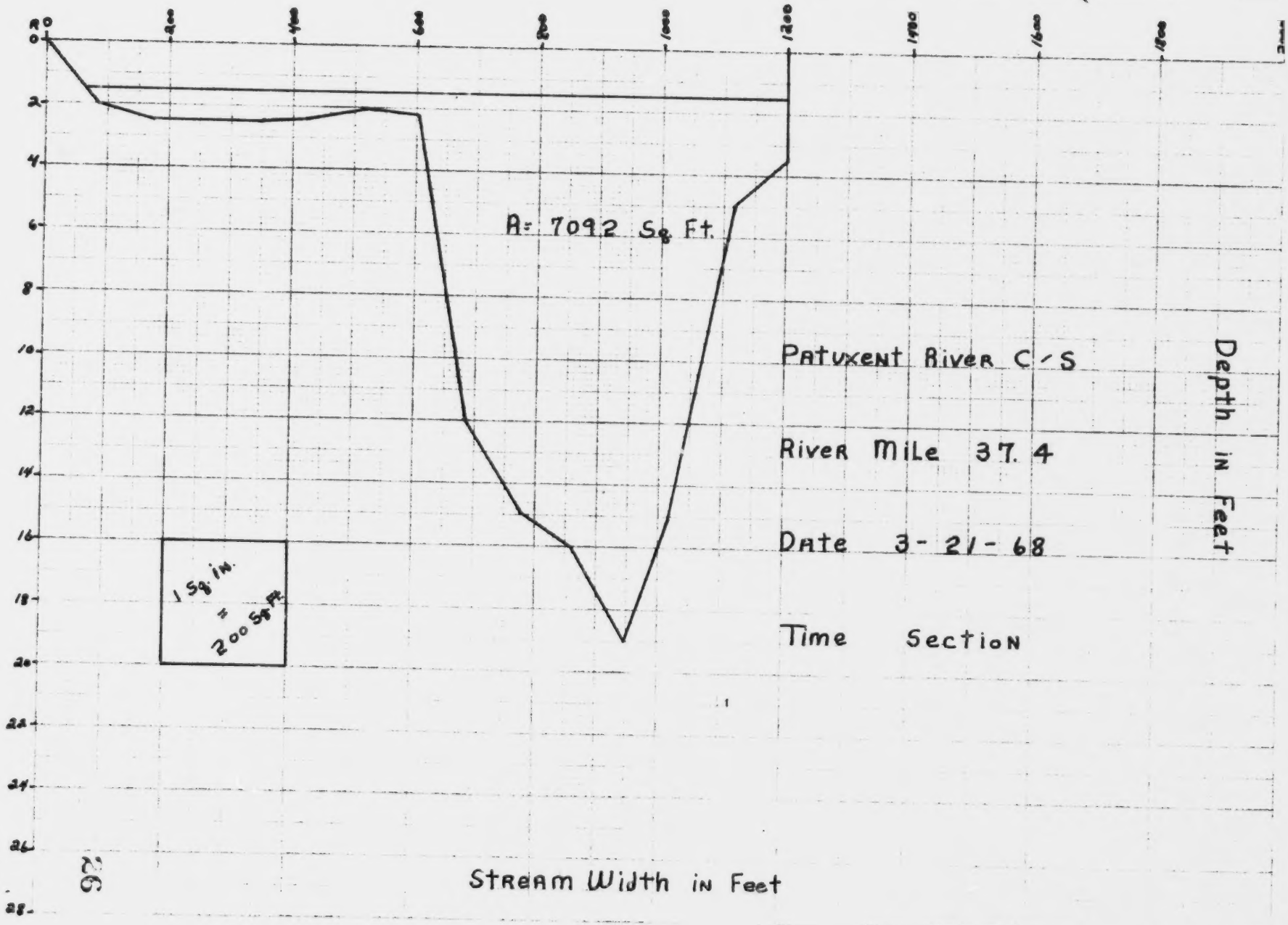
III - C. CROSS-SECTION [illegible]

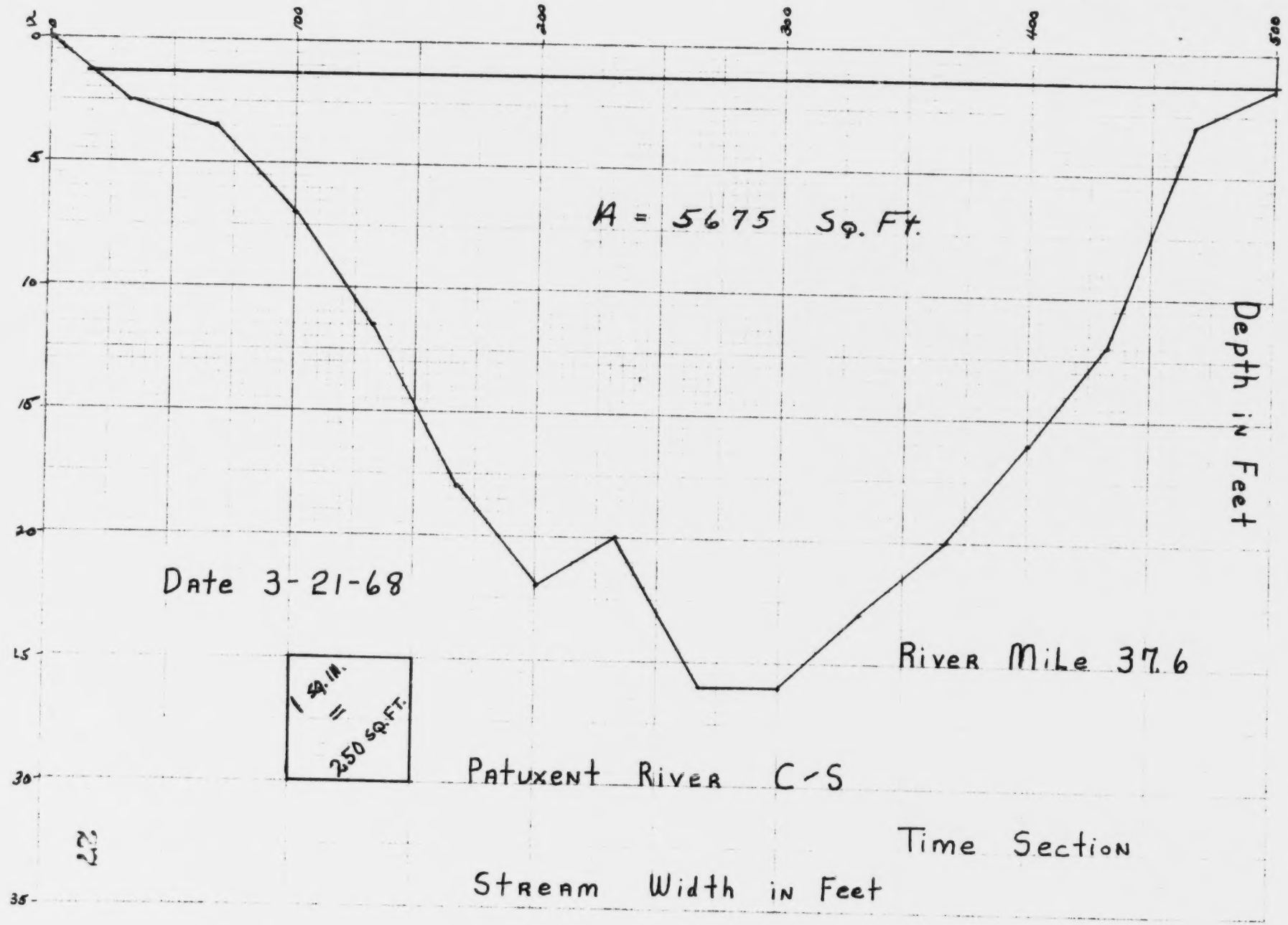
(RIVER MILE 36. TO 3.0)

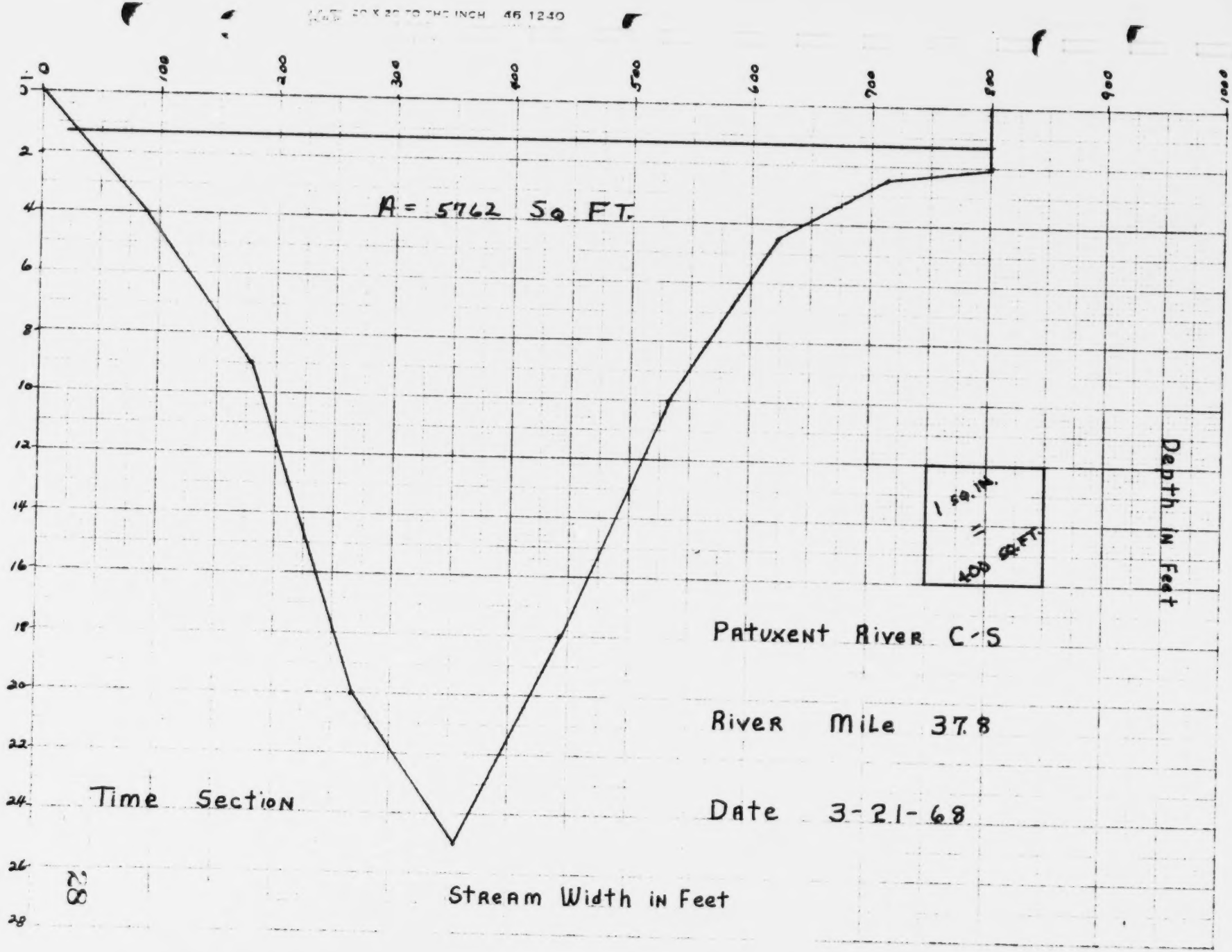

0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
A• 1694 Sq. Ft.
1/8 IN. = 200 SQ FT.
Depth in Feet
PATUXENT RIVER C-S
Time Section
River Mile 36.8
Date 3-21-68
Stream Width in Feet

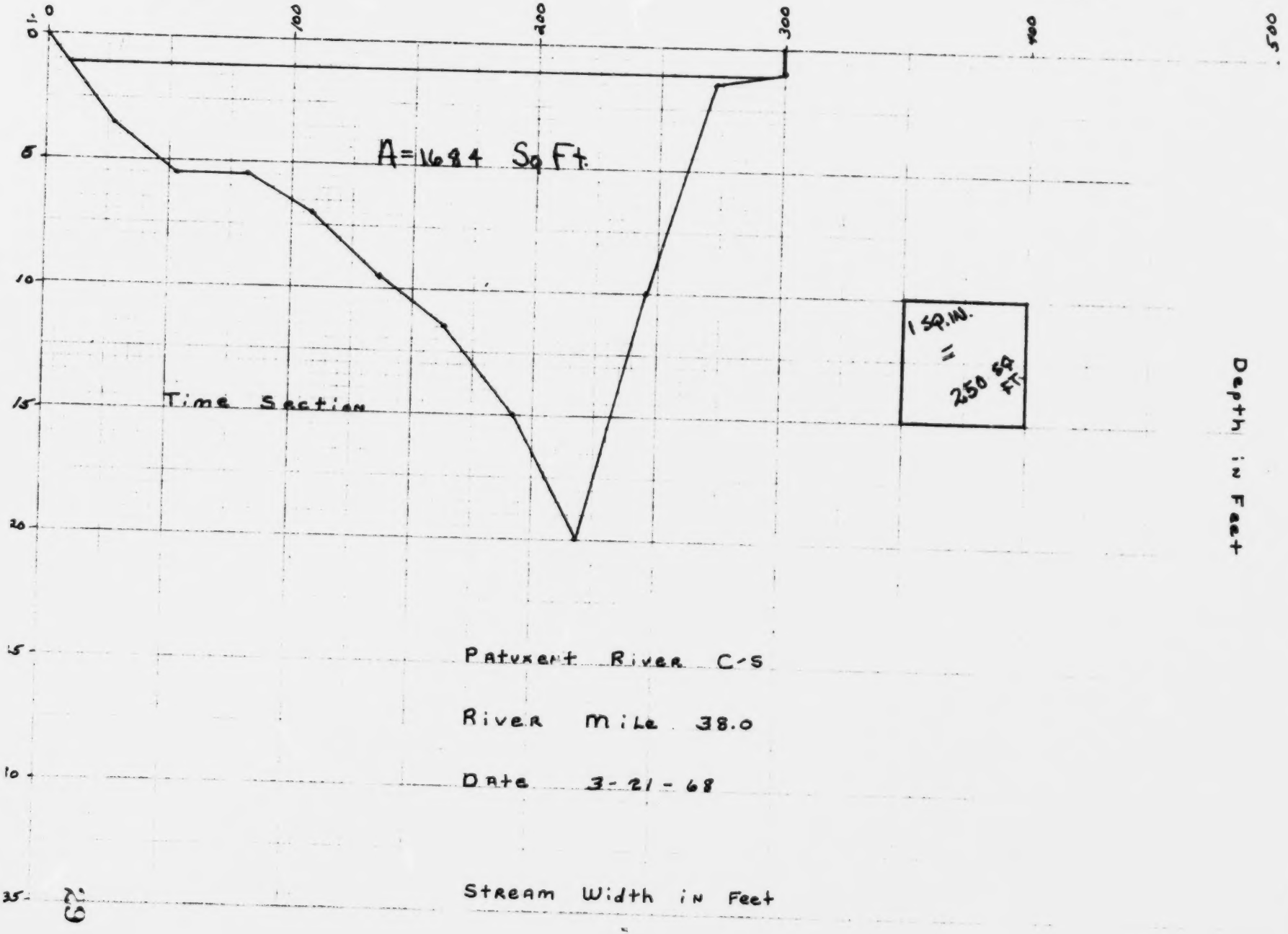

0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
A = 7528 Sq. Ft.
1 Sq. in. = 400 Sq. Ft.
Patuxent River C-5
River Mile 37.0
Date 3-21-68
Time Section
Depth in Feet
Stream Width in Feet

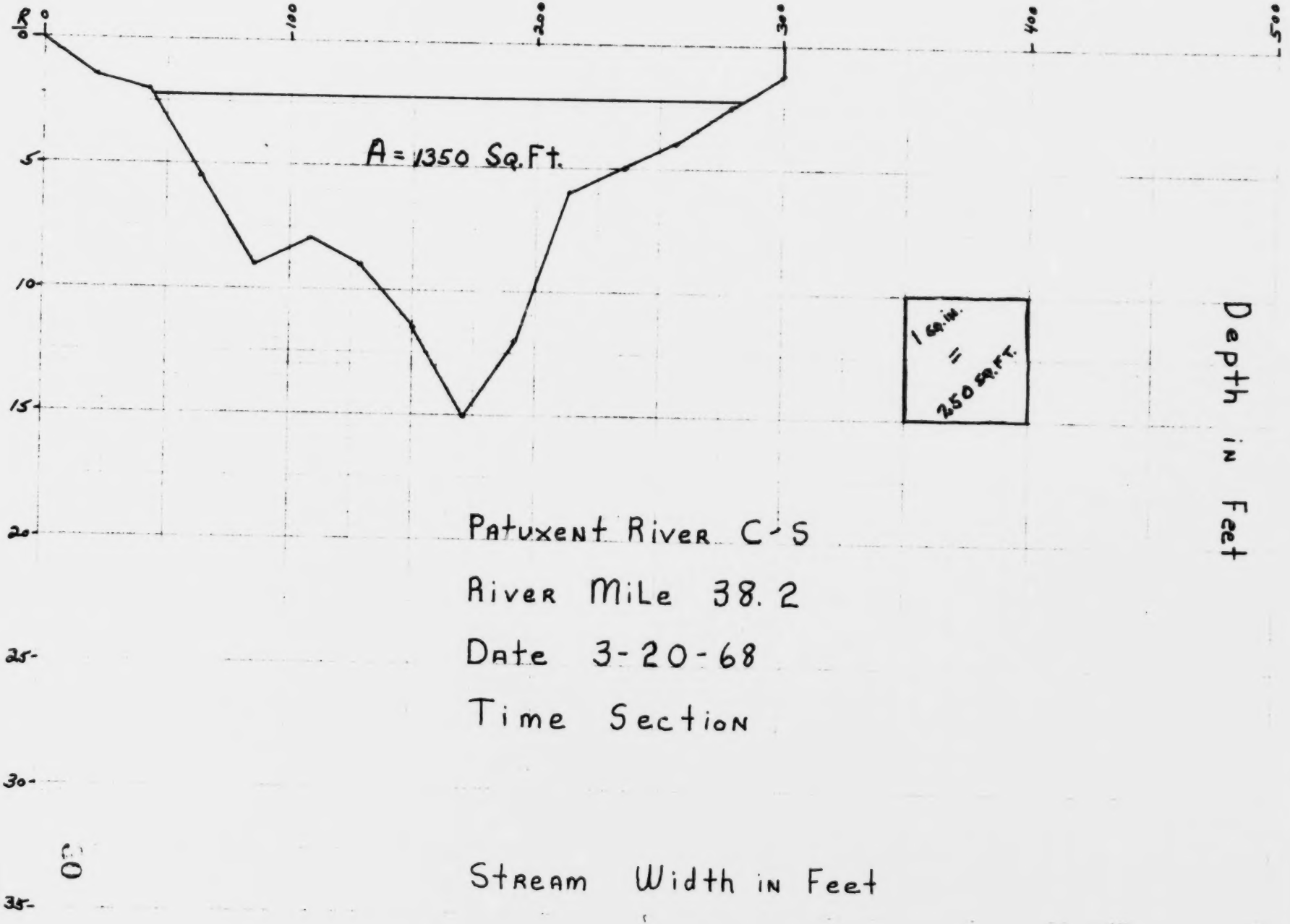

A= 8858 Sq. Ft.
Patuxent River C-S
River Mile 37.2
Date 3-21-68
Time Section
Depth in Feet
Stream Width in Feet
1 Sq. in. = 400 Sq. Ft.


A= 7092 Sq Ft.
1 Sq in. = 200 Sq Ft.
Patuxent River C/S
River Mile 37.4
Date 3-21-68
Time Section
Depth in Feet
Stream Width in Feet


0
100
200
300
400
500
5
10
15
20
25
30
35
A = 5675 Sq. Ft.
Depth in Feet
Date 3-21-68
River Mile 37.6
1 Sq. In. = 250 Sq. Ft.
Patuxent River C-S
Time Section
Stream Width in Feet


A = 5762 SQ FT.
1 SQ. IN. = 400 SQ. FT.
Depth in Feet
Stream Width in Feet
Patuxent River C-S
River Mile 37.8
Date 3-21-68
Time Section


0
100
200
300
400
500
5
10
15
20
A=1694 Sq Ft.
Time Section
1 SQ.IN. = 250 SQ FT.
Depth in Feet
Patuxent River C-S
River Mile 38.0
Date 3-21-68
Stream Width in Feet


0
100
200
300
400
500
5
10
15
20
25
30
35
A = 1350 Sq. Ft.
1 Sq. In. = 250 Sq. Ft.
Depth in Feet
Patuxent River C-S
River Mile 38.2
Date 3-20-68
Time Section
Stream Width in Feet

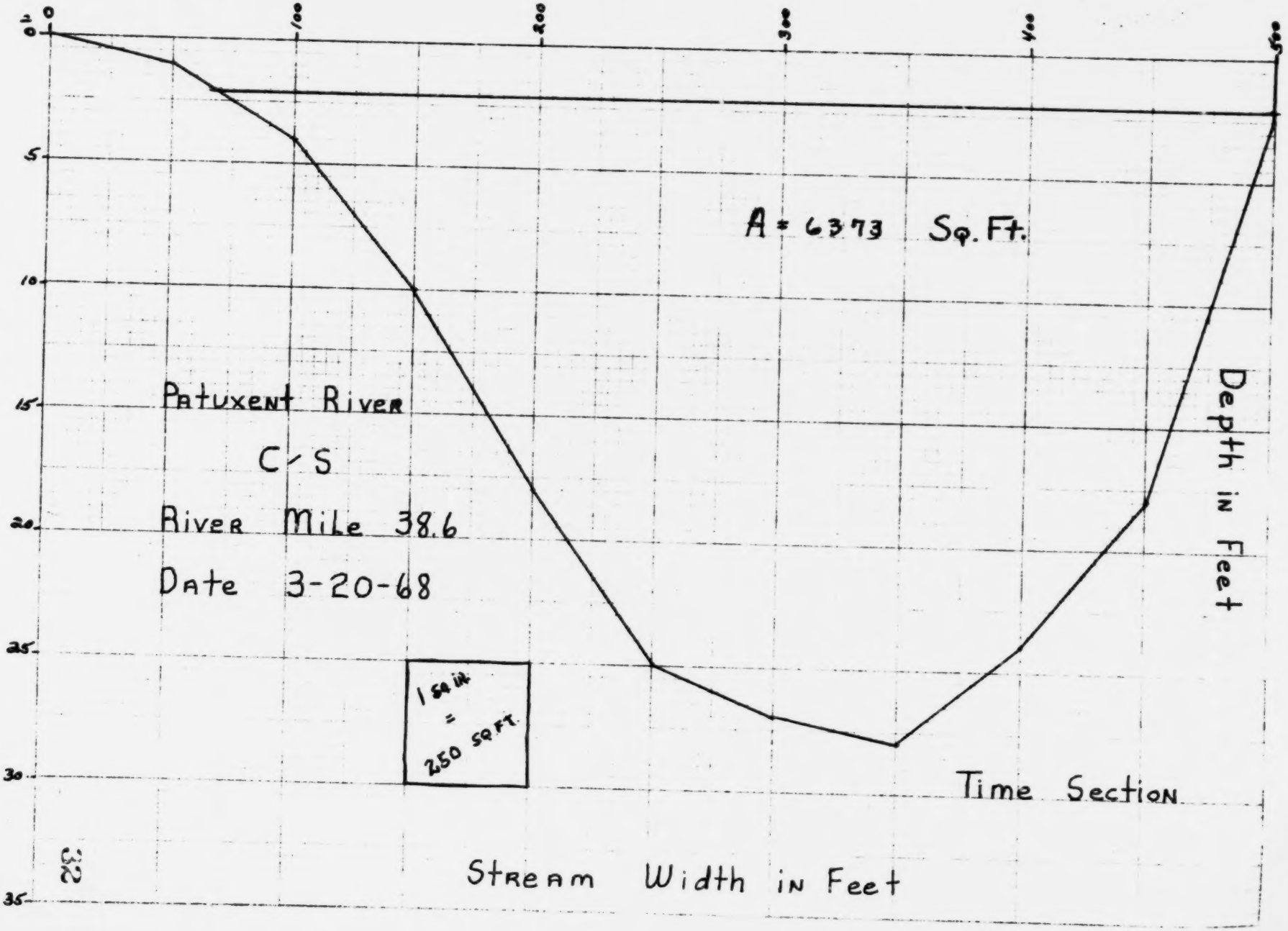
Patuxent River C-5

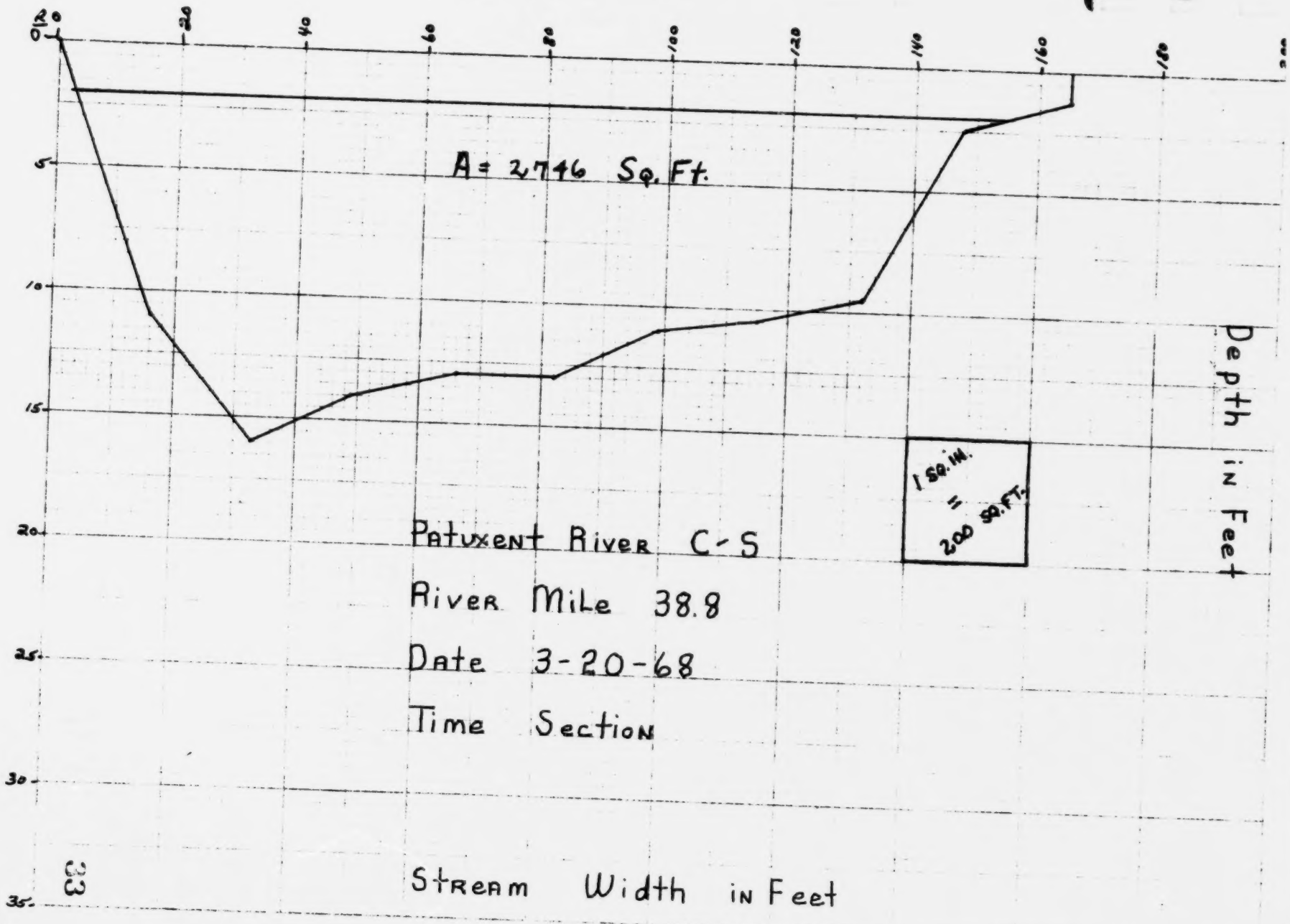
River Mile 38.4

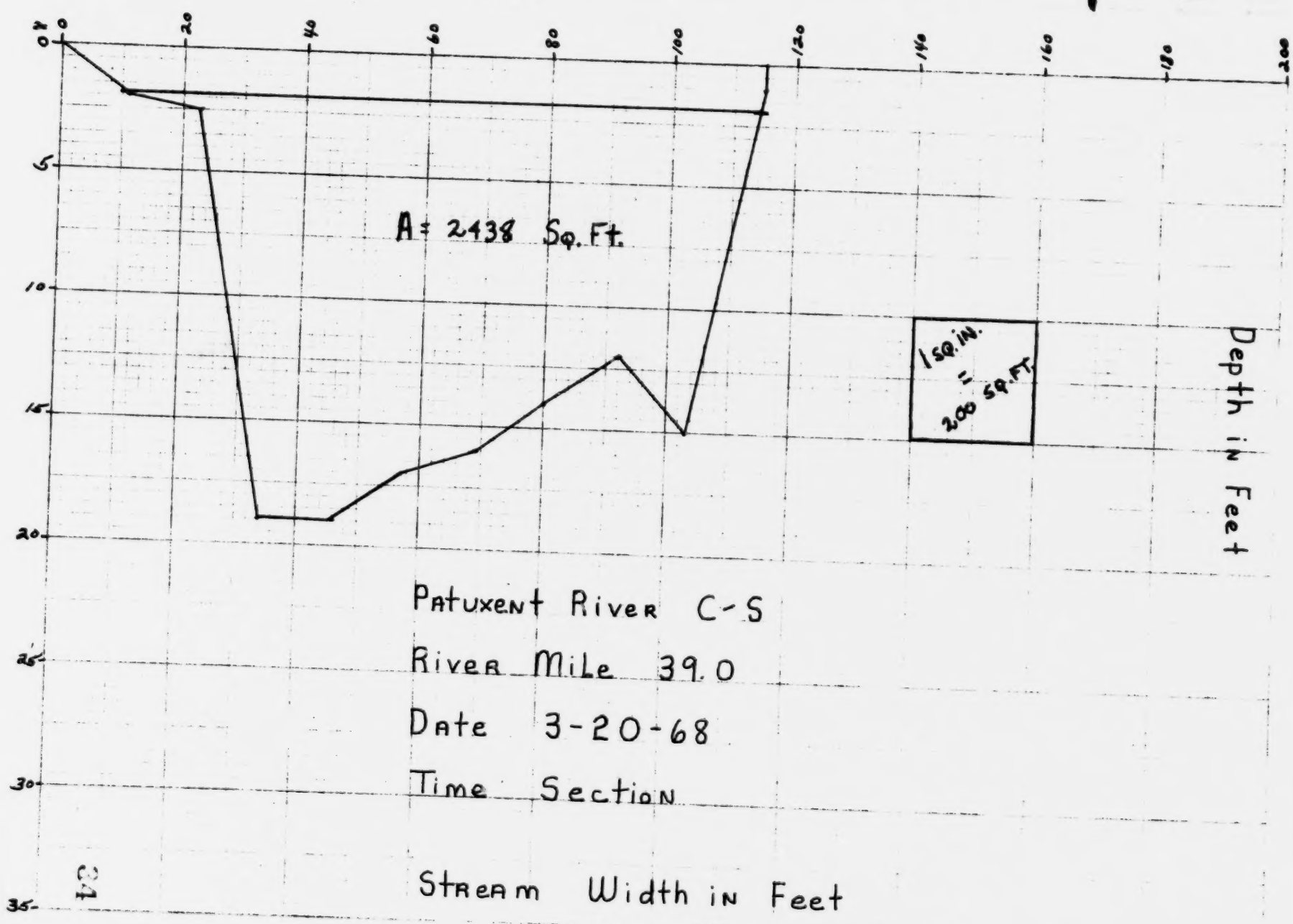
Date 3-20-68

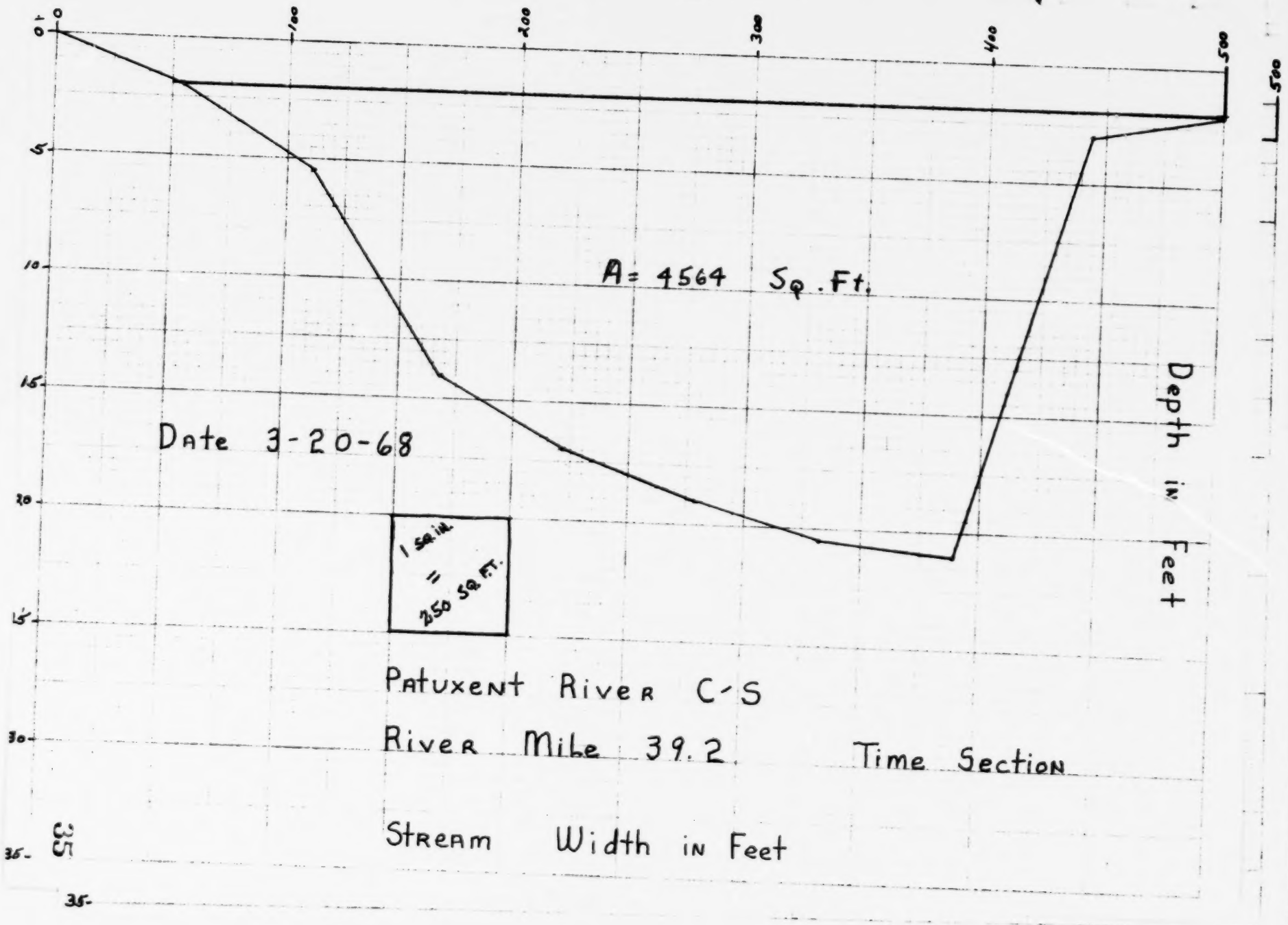
Time Section

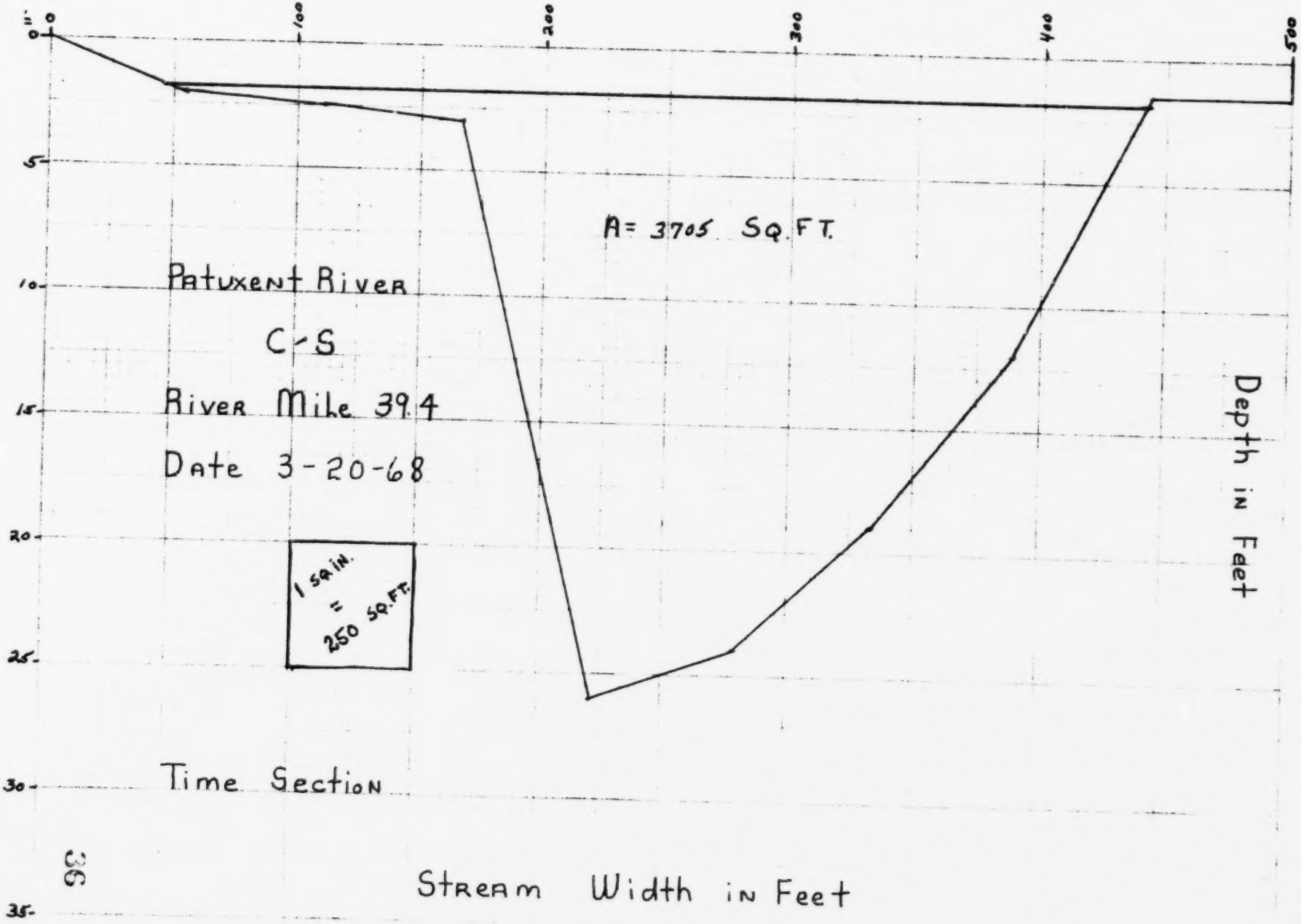
Stream Width in Feet

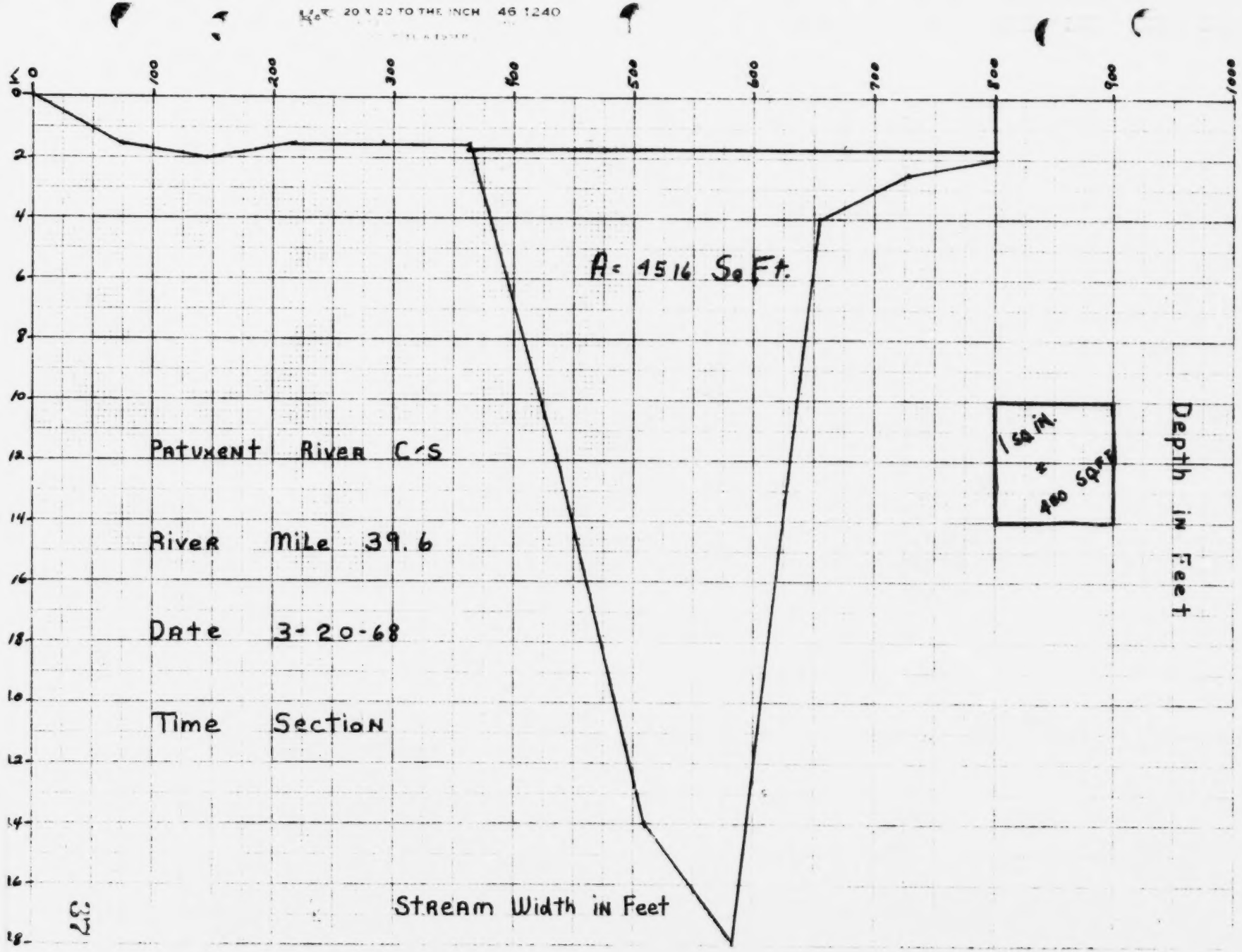

A = 6373 Sq. Ft.
Patuxent River
C/S
River Mile 38.6
Date 3-20-68
1 sq in = 250 sq ft
Time Section
Depth in Feet
Stream Width in Feet
0
100
200
300
400
5
10
15
20
25
30
35

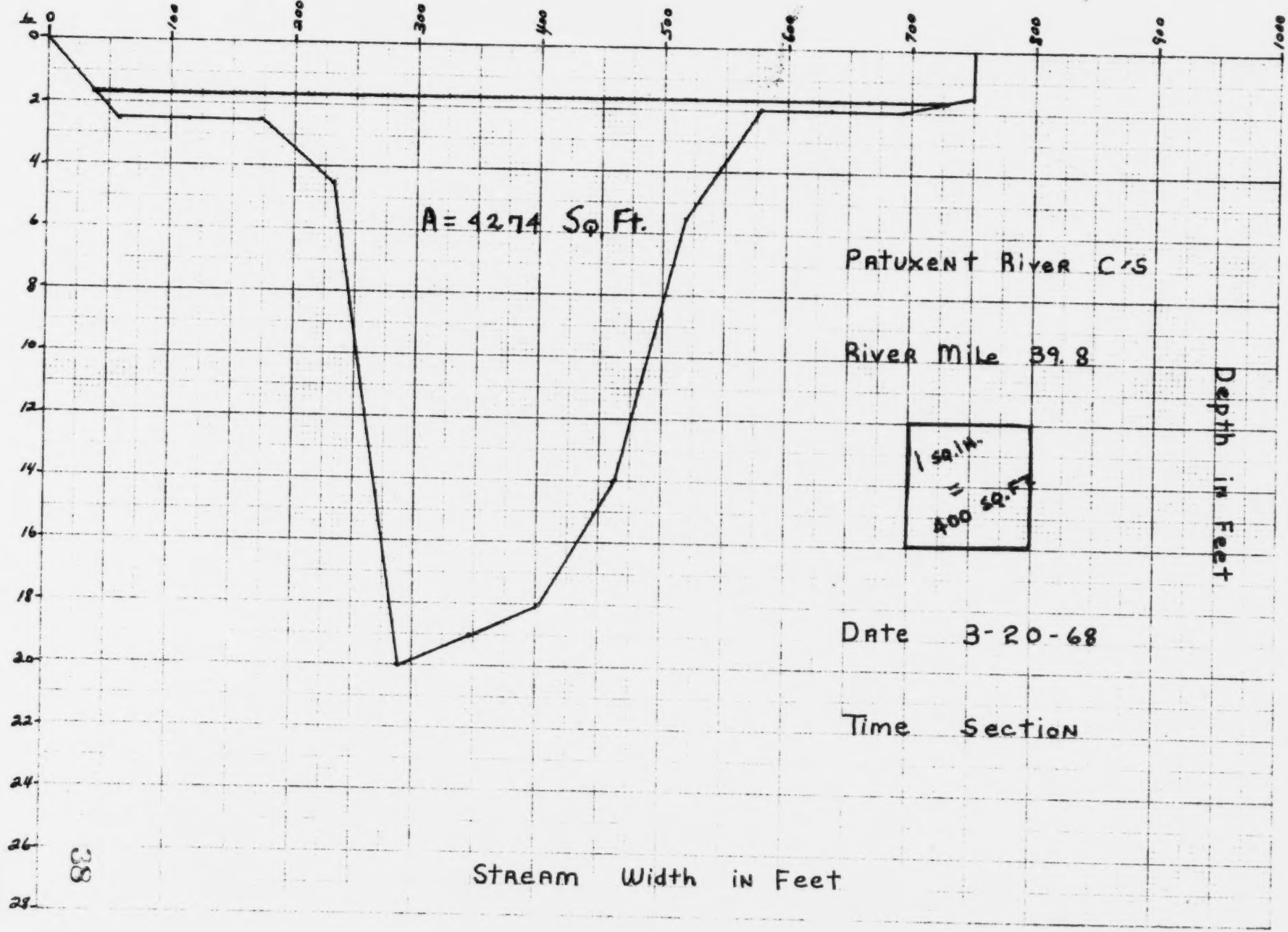

A = 2,746 Sq. Ft.
1 SQ. IN. = 200 SQ. FT.
Patuxent River C-S
River Mile 38.8
Date 3-20-68
Time Section
Depth in Feet
Stream Width in Feet

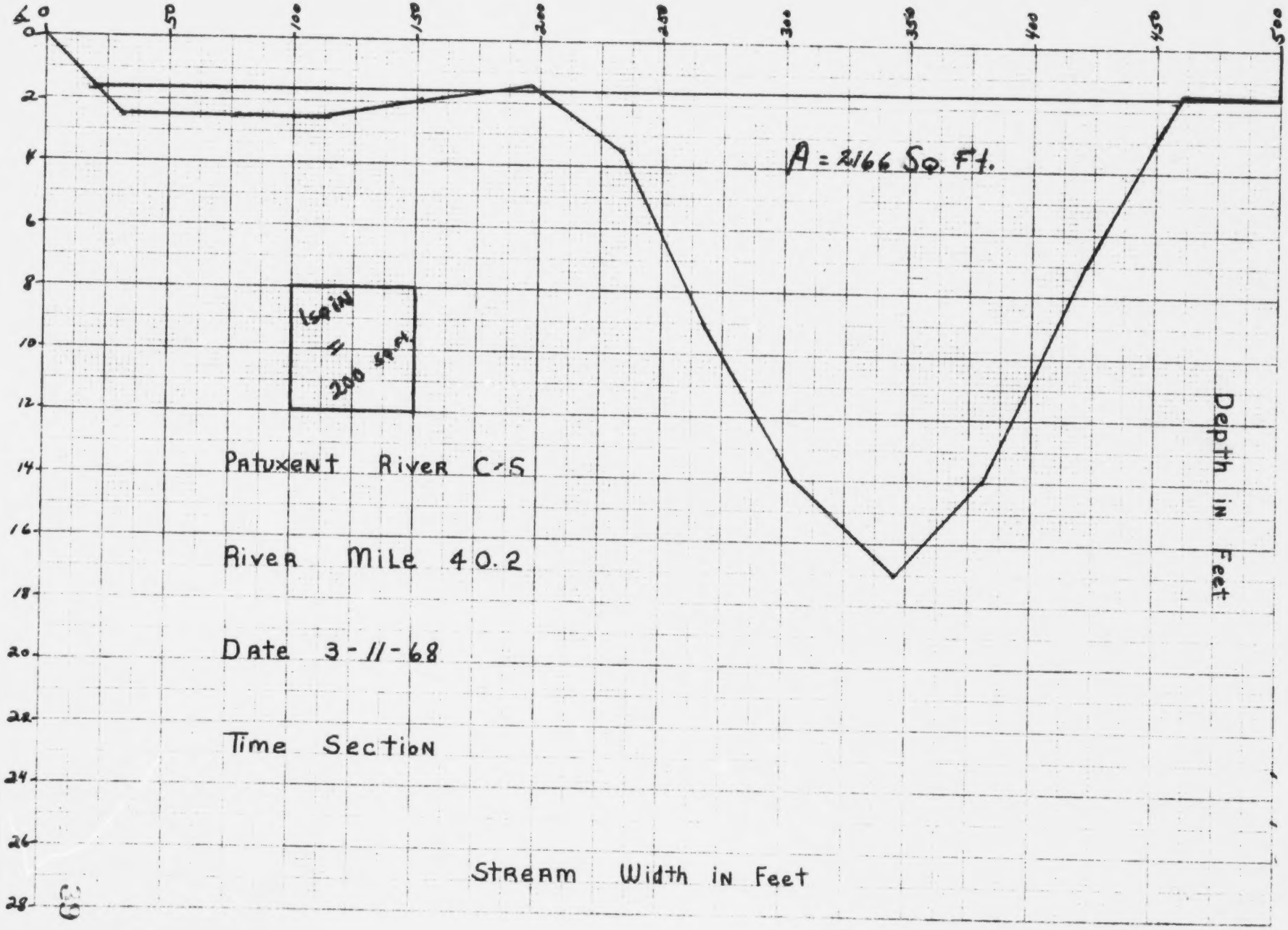

K+E 10 X 10 TO THE INCH 46 0780
0
20
40
60
80
100
120
140
160
180
200
5
10
15
20
25
30
35
A = 2438 Sq. Ft.
1 SQ. IN. = 200 SQ. FT.
Depth in Feet
Patuxent River C-S
River Mile 39.0
Date 3-20-68
Time Section
Stream Width in Feet

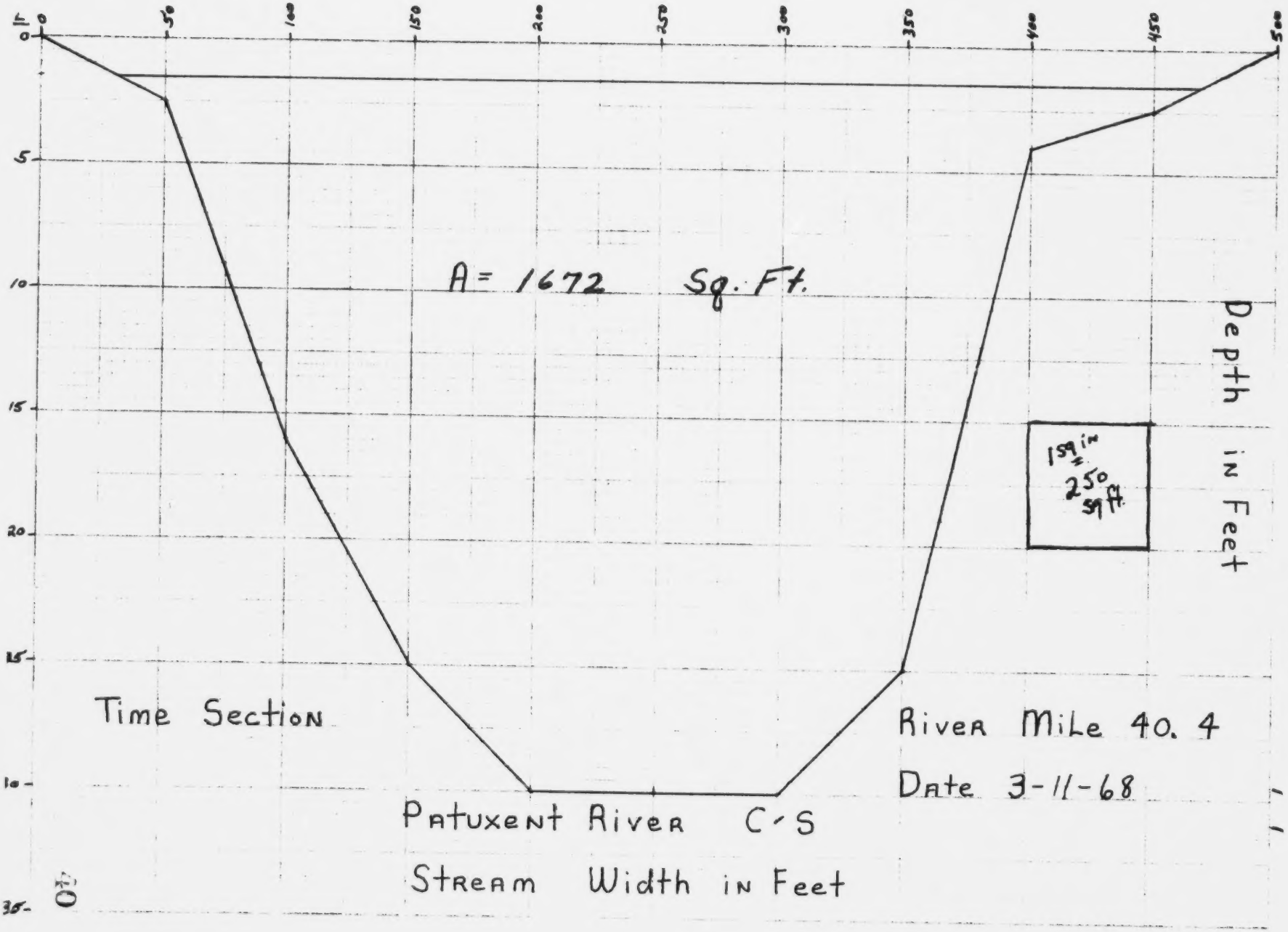

0
100
200
300
400
500
5
10
15
20
25
30
35
A= 4564 Sq. Ft.
Date 3-20-68
1 Sq. in. = 250 Sq. Ft.
Depth in Feet
Patuxent River C-S
River Mile 39.2
Time Section
Stream Width in Feet

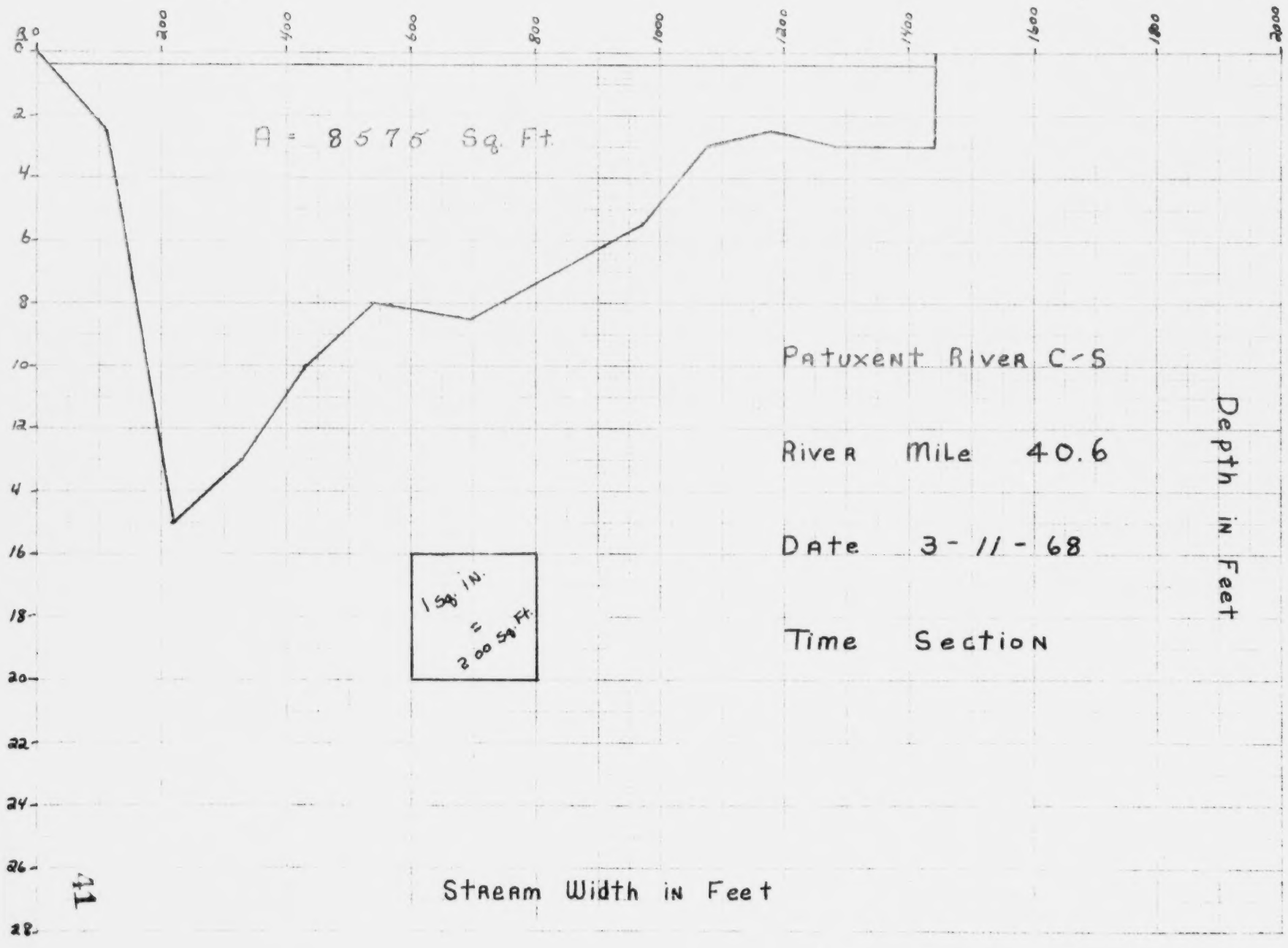

0
100
200
300
400
500
5
10
15
20
25
30
35
A= 3705 SQ. FT.
Patuxent River
C-S
River Mile 39.4
Date 3-20-68
1 SQ IN. = 250 SQ. FT.
Time Section
Depth in Feet
Stream Width in Feet

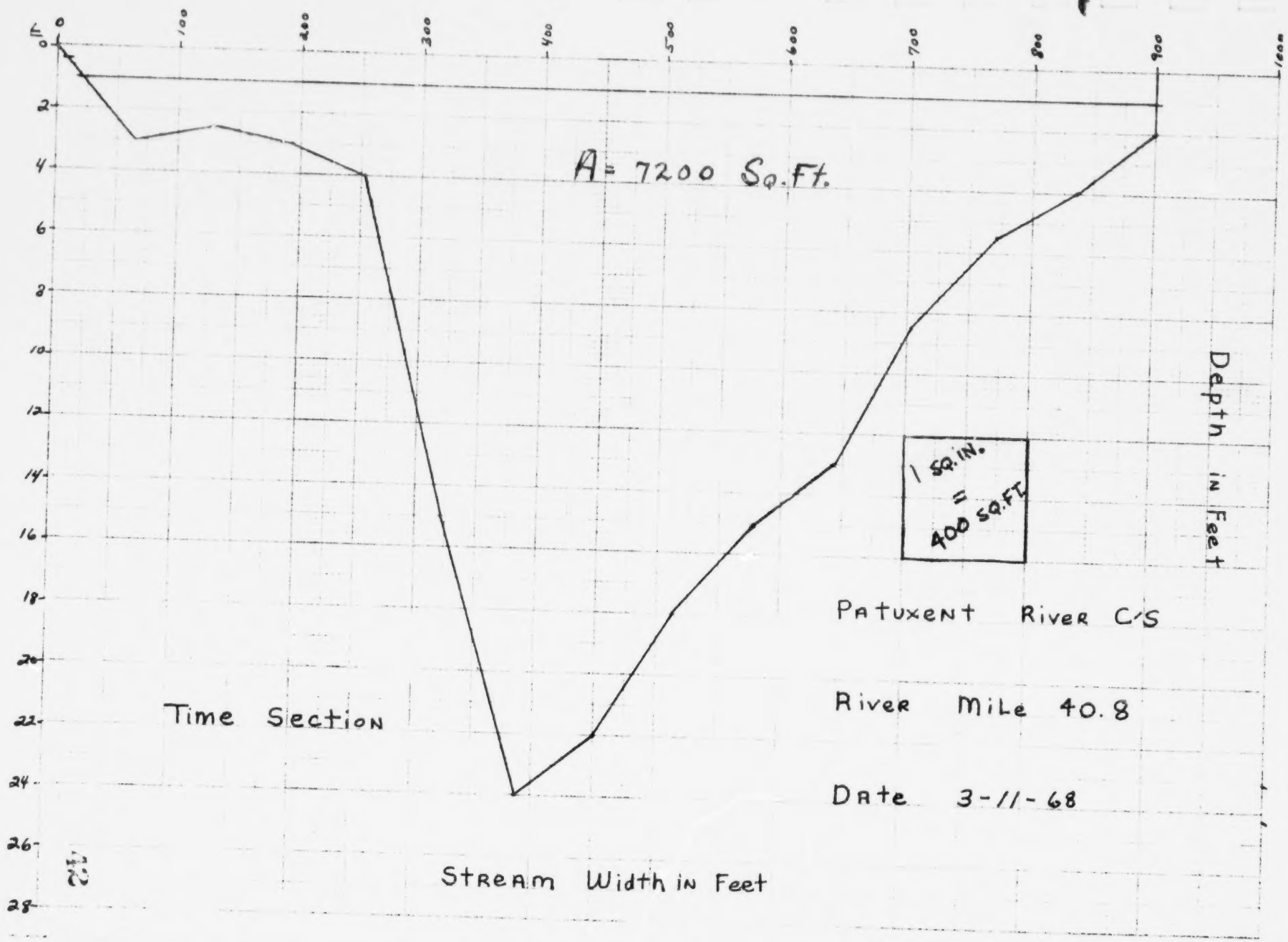

20 X 20 TO THE INCH 46 1240
0
100
200
300
400
500
600
700
800
900
1000
2
4
6
8
10
12
14
16
18
A = 4516 Sq Ft.
Patuxent River C-S
River Mile 39.6
Date 3-20-68
Time Section
1/4 in. = 40 sqft
Depth in Feet
Stream Width in Feet

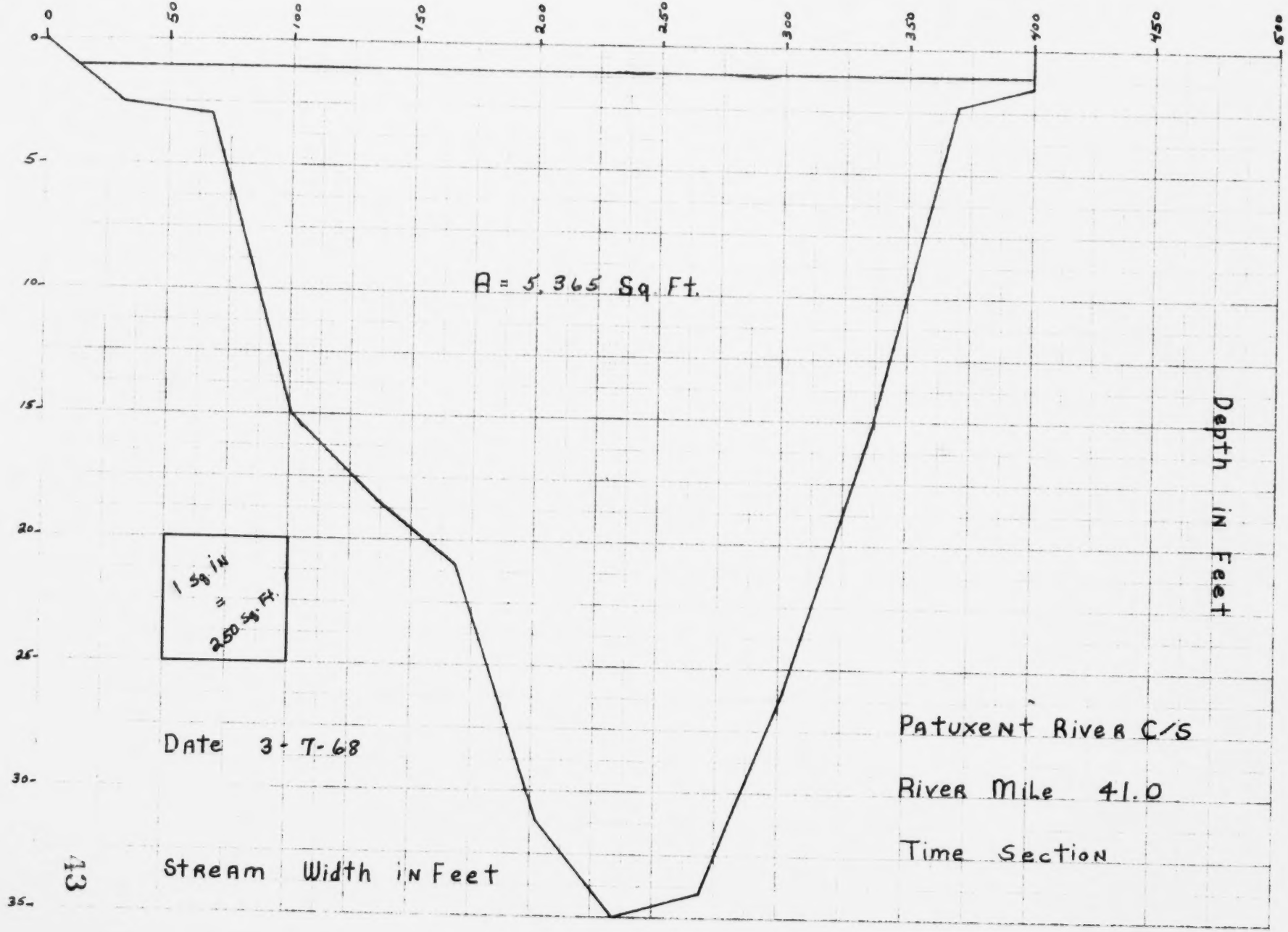

A = 4274 Sq. Ft.
Patuxent River C/S
River Mile 39.8
1 sq. in. = 400 sq. ft.
Date 3-20-68
Time Section
Depth in Feet
Stream Width in Feet
0
100
200
300
400
500
600
700
800
900
1000
2
4
6
8
10
12
14
16
18
20
22
24
26
28

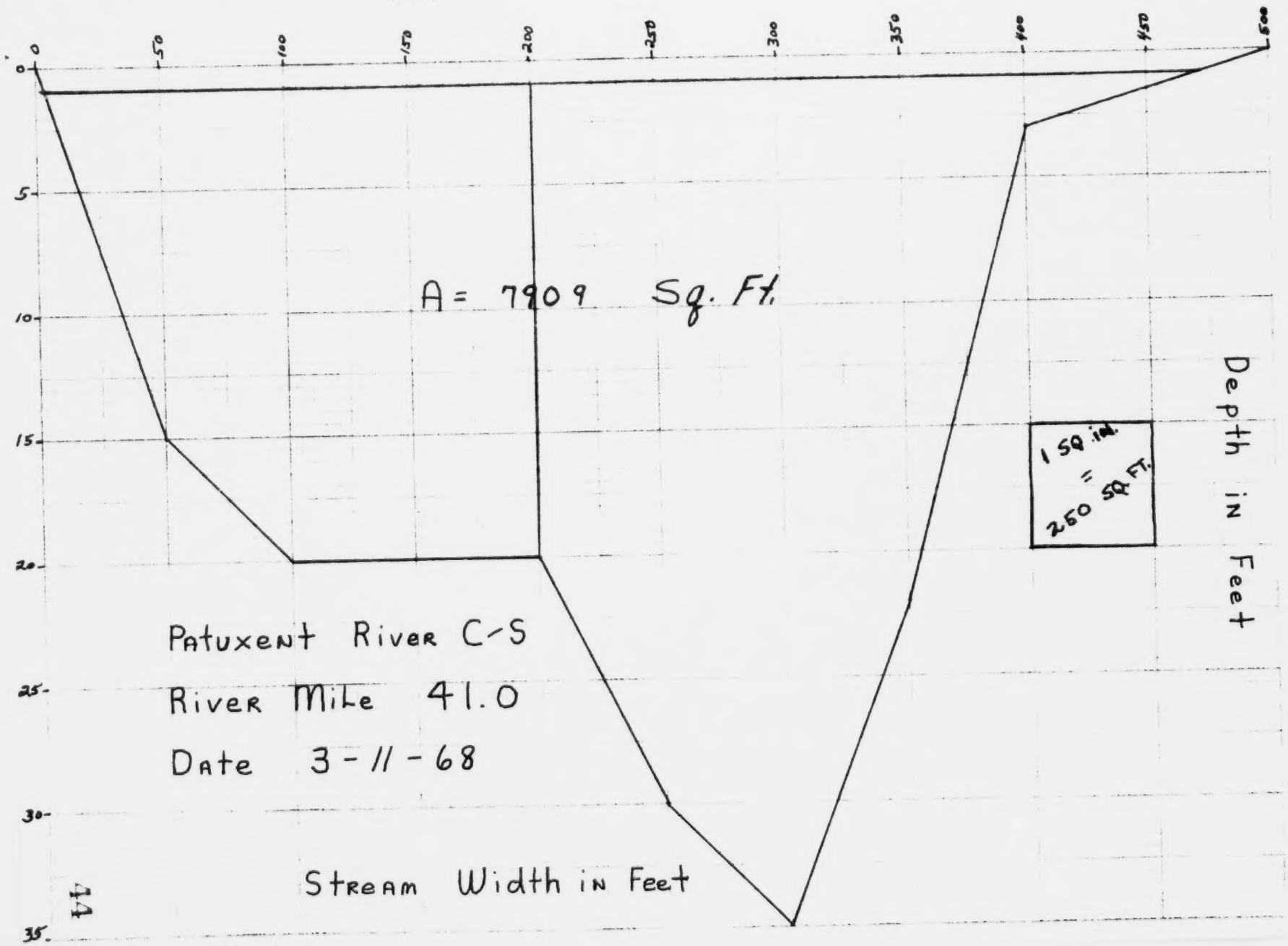

0
50
100
150
200
250
300
350
400
450
500
2
4
6
8
10
12
14
16
18
20
22
24
26
28
A = 2166 Sq. Ft.
1 Sq in = 200 Sq ft
Patuxent River C-S
River Mile 40.2
Date 3-11-68
Time Section
Depth in Feet
Stream Width in Feet


0
50
100
150
200
250
300
350
400
450
500
0
5
10
15
20
25
30
35
A = 1672 Sq. Ft.
Depth in Feet
1.5 in = 250 sq ft
Time Section
River Mile 40.4
Date 3-11-68
Patuxent River C-S
Stream Width in Feet

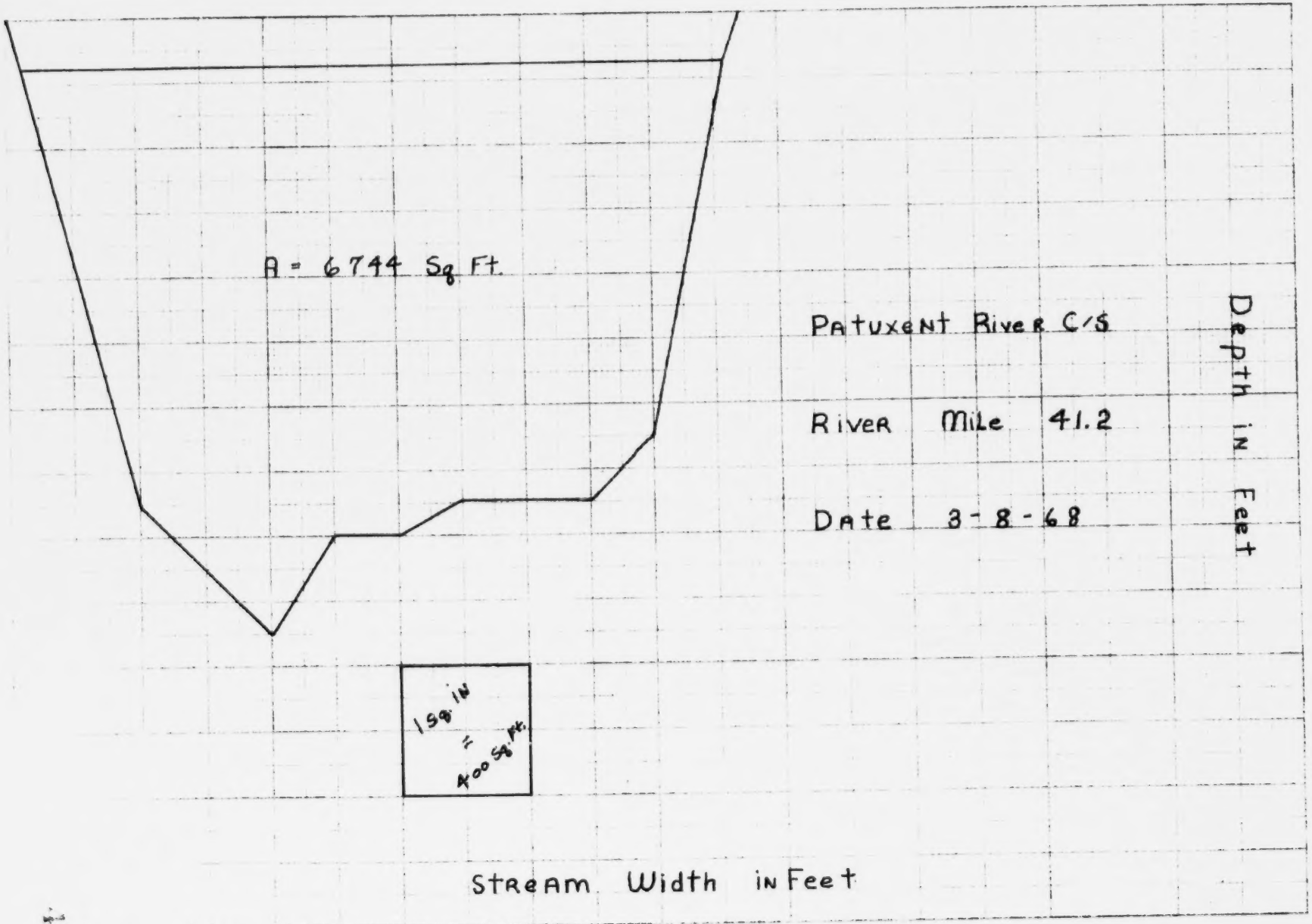

A = 8576 Sq. Ft.
1 Sq. In. = 200 Sq. Ft.
Patuxent River C-S
River Mile 40.6
Date 3-11-68
Time Section
Depth in Feet
Stream Width in Feet
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2
4
6
8
10
12
14
16
18
20
22
24
26
28

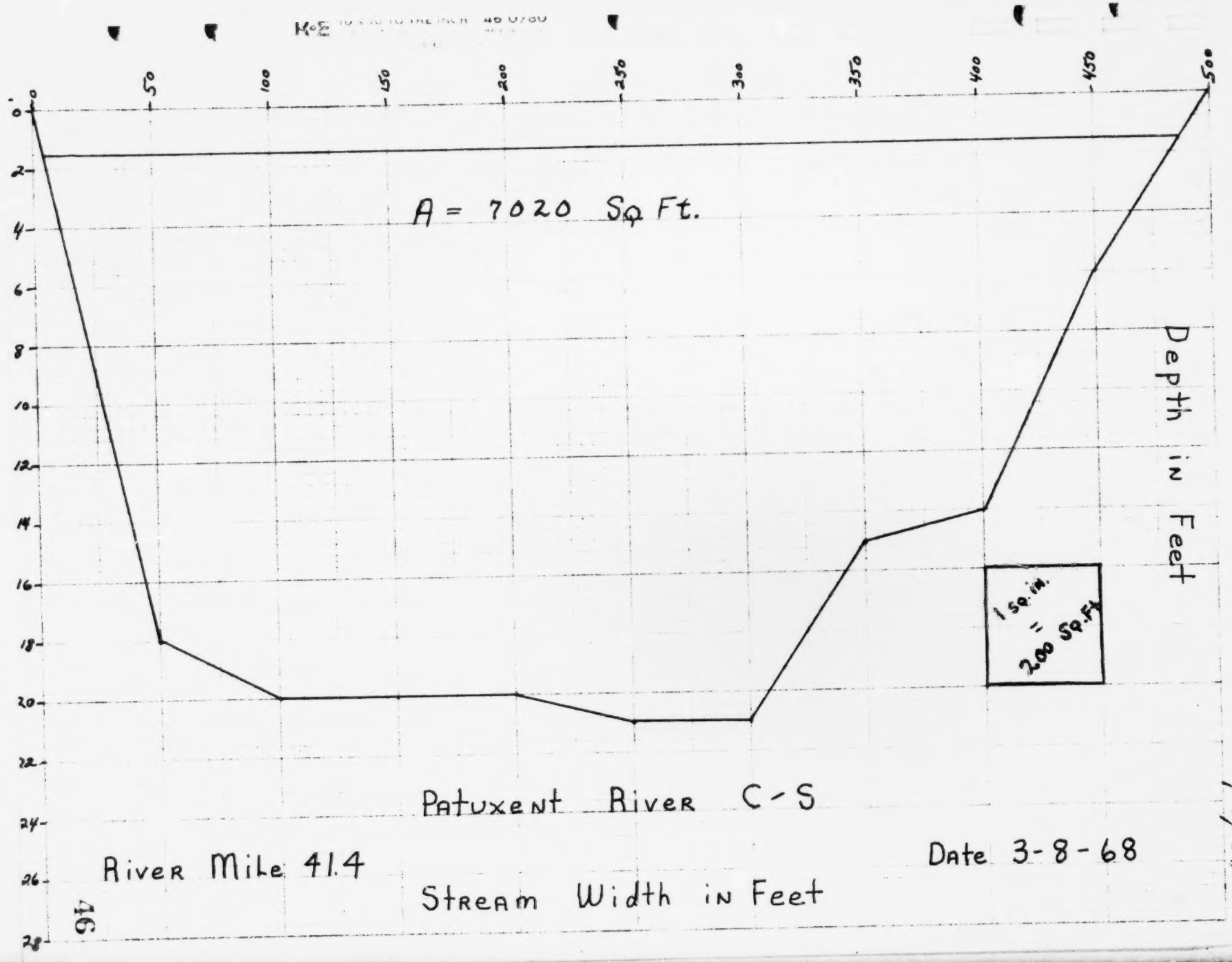

A = 7200 Sq. Ft.
1 SQ. IN. = 400 SQ. FT.
Depth in Feet
Stream Width in Feet
Time Section
Patuxent River C/S
River Mile 40.8
Date 3-11-68

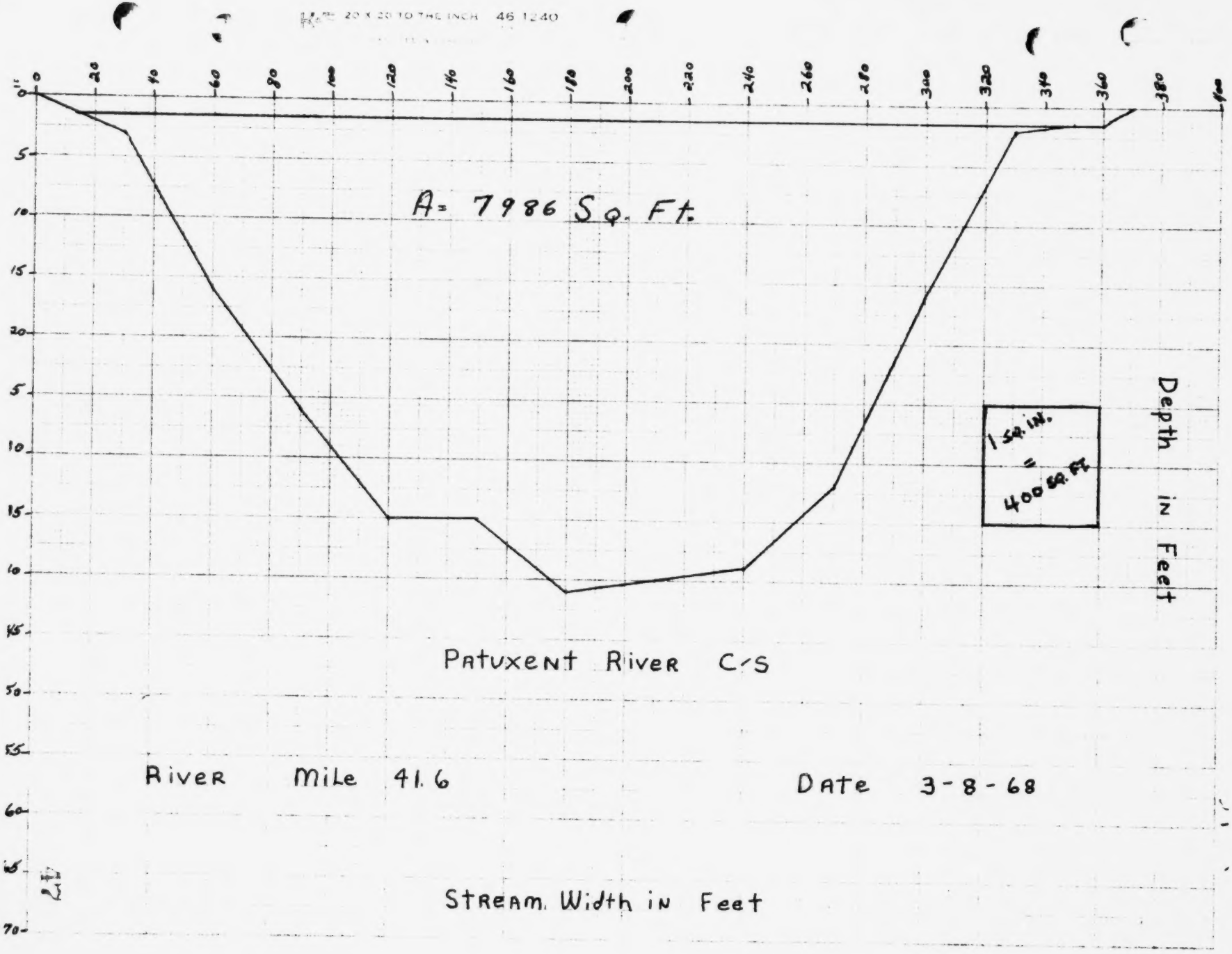

0
50
100
150
200
250
300
350
400
450
500
5
10
15
20
25
30
35
A = 5,365 Sq Ft.
1 Sq IN = 250 Sq. Ft.
Depth IN Feet
Date 3-7-68
Patuxent River C/S
River Mile 41.0
Time Section
Stream Width IN Feet

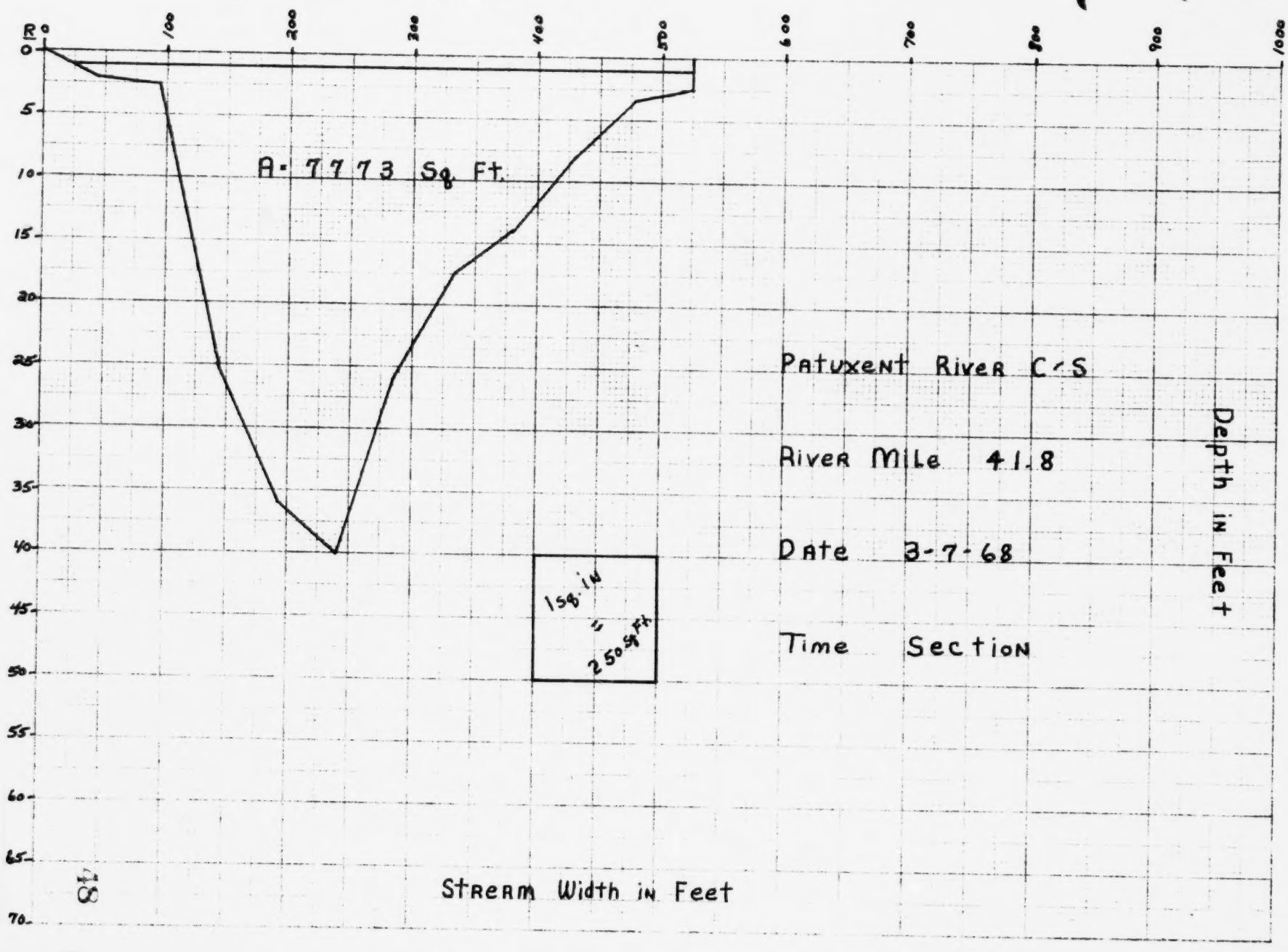

0
50
100
150
200
250
300
350
400
450
500
0
5
10
15
20
25
30
35
A = 7909 Sq. Ft.
1 Sq. in. = 250 Sq. Ft.
Depth in Feet
Patuxent River C-S
River Mile 41.0
Date 3-11-68
Stream Width in Feet

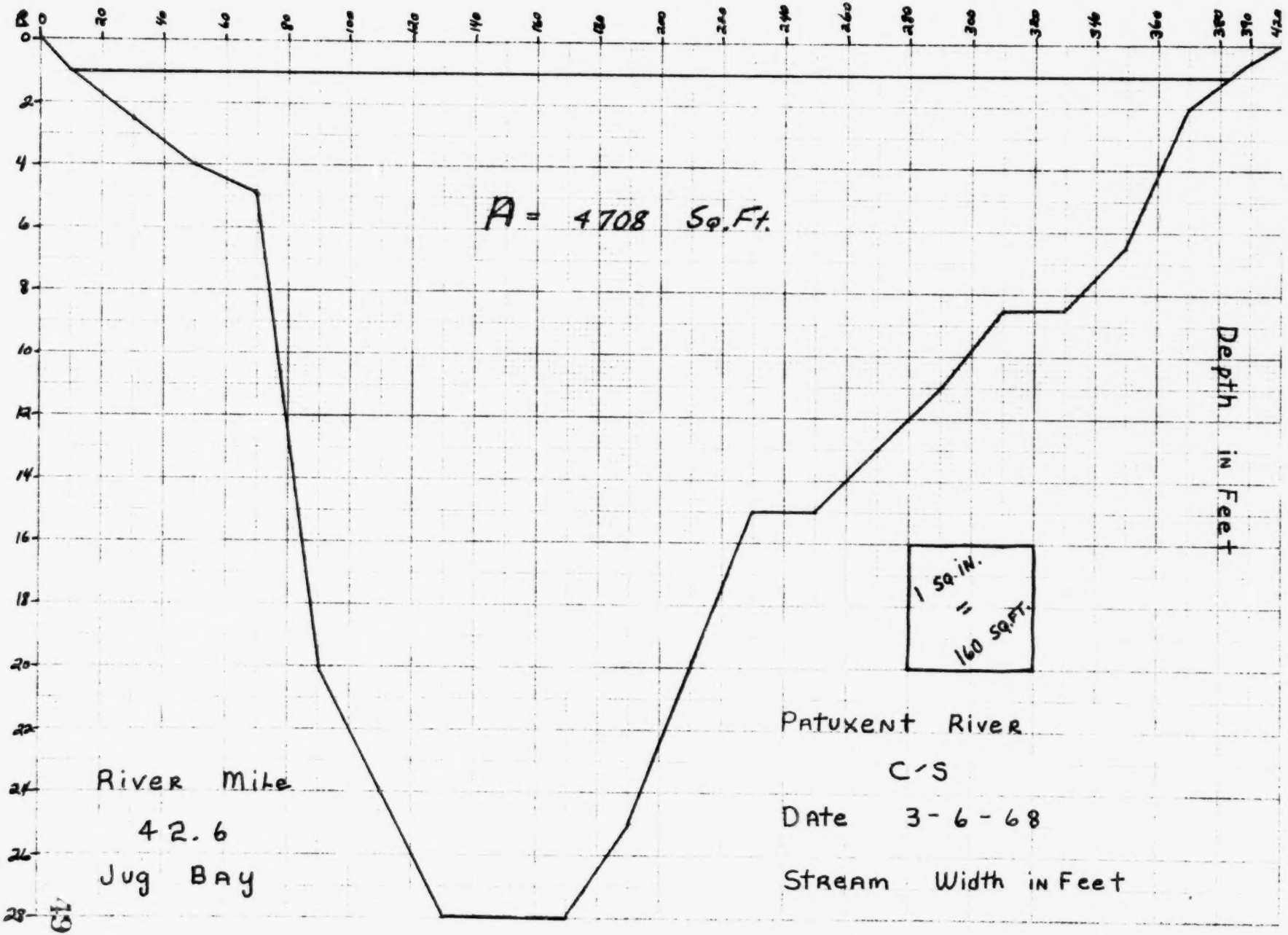
K+E 20 X 20 TO THE INCH 46 1242

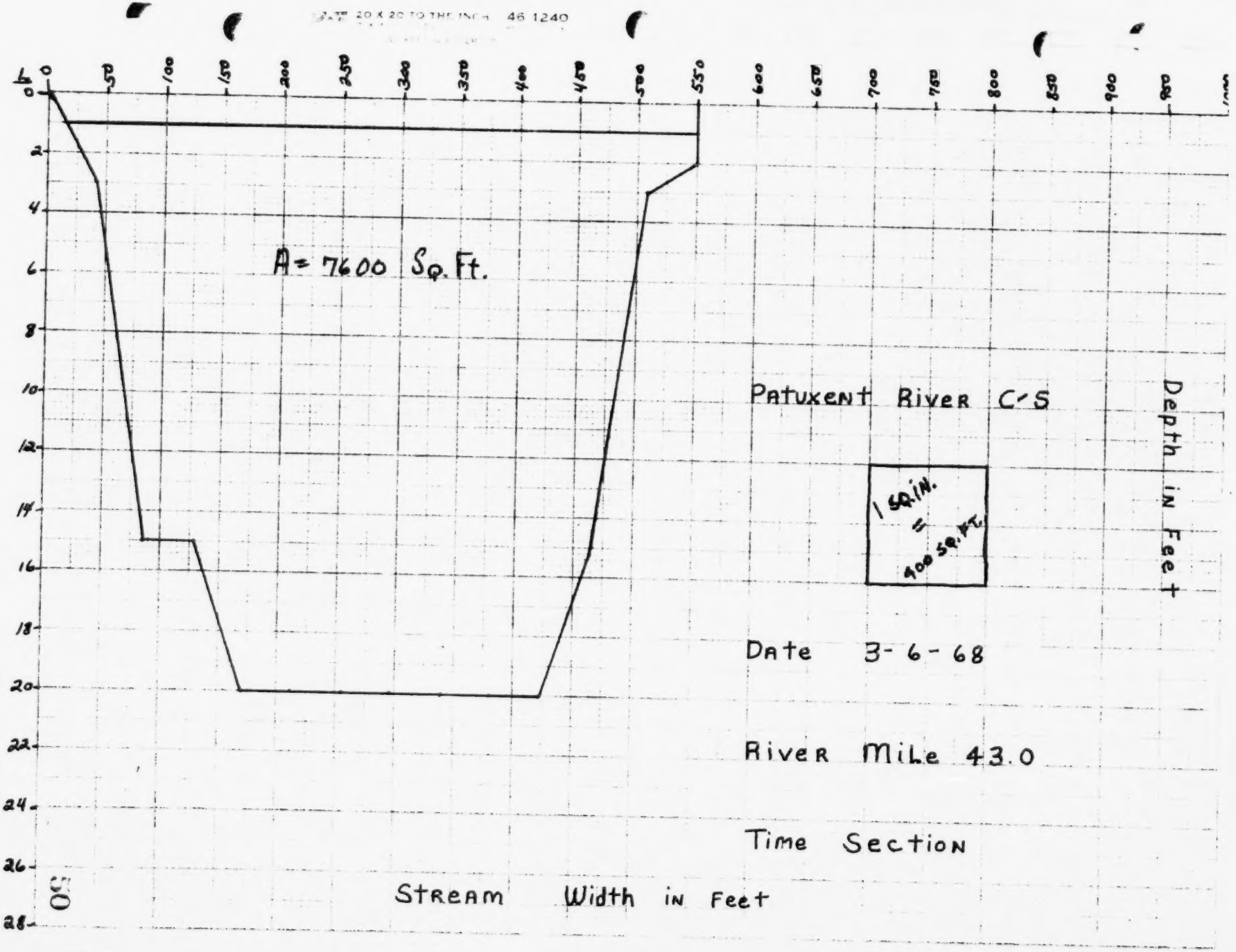



A = 7020 Sq Ft.
Depth in Feet
1 Sq. in. = 200 Sq. Ft.
Patuxent River C-S
River Mile 41.4
Date 3-8-68
Stream Width in Feet

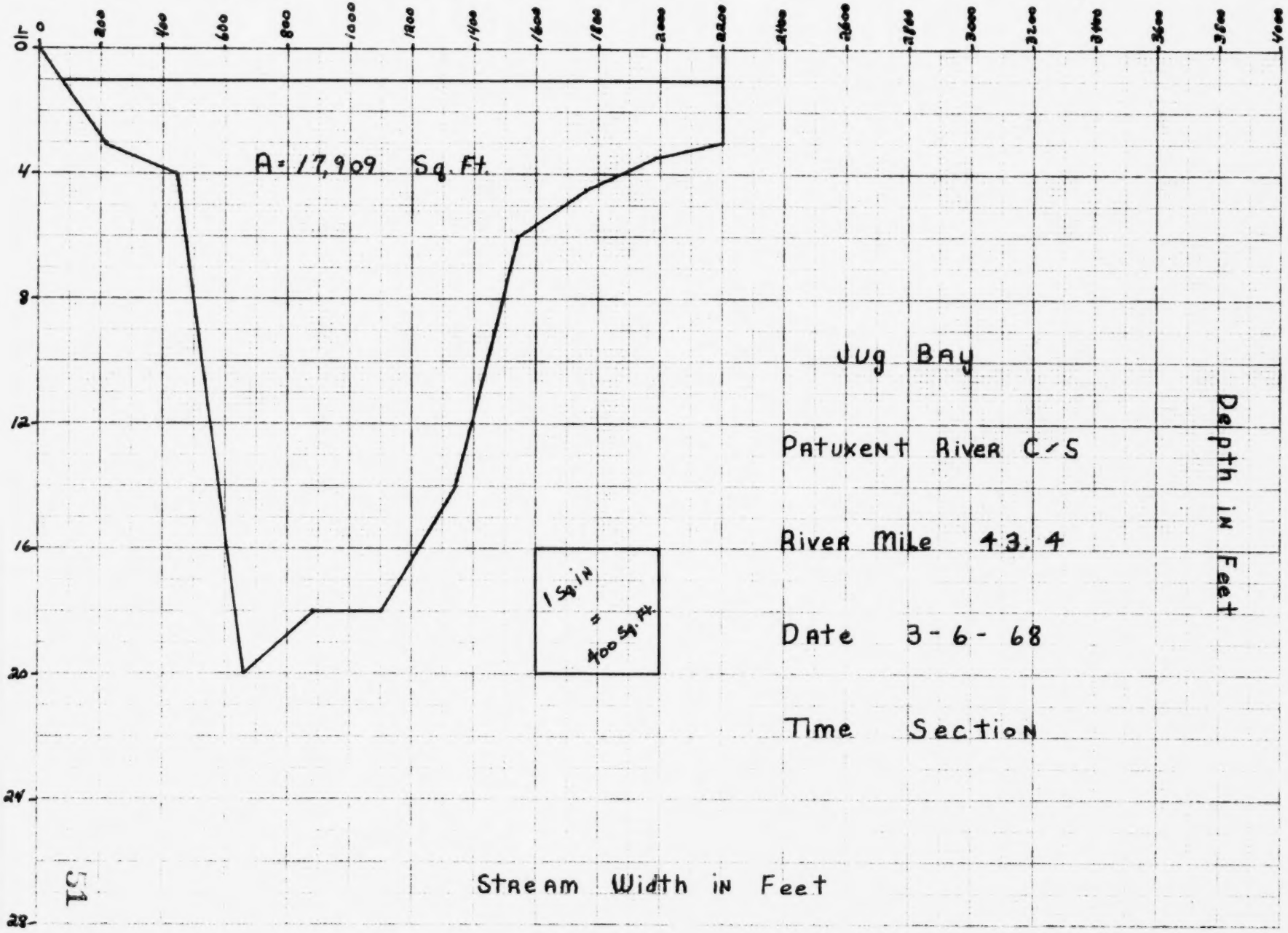

A= 7986 Sq. Ft.
1 sq. in. = 400 sq. ft.
Depth in Feet
Patuxent River C-S
River Mile 41.6
Date 3-8-68
Stream Width in Feet

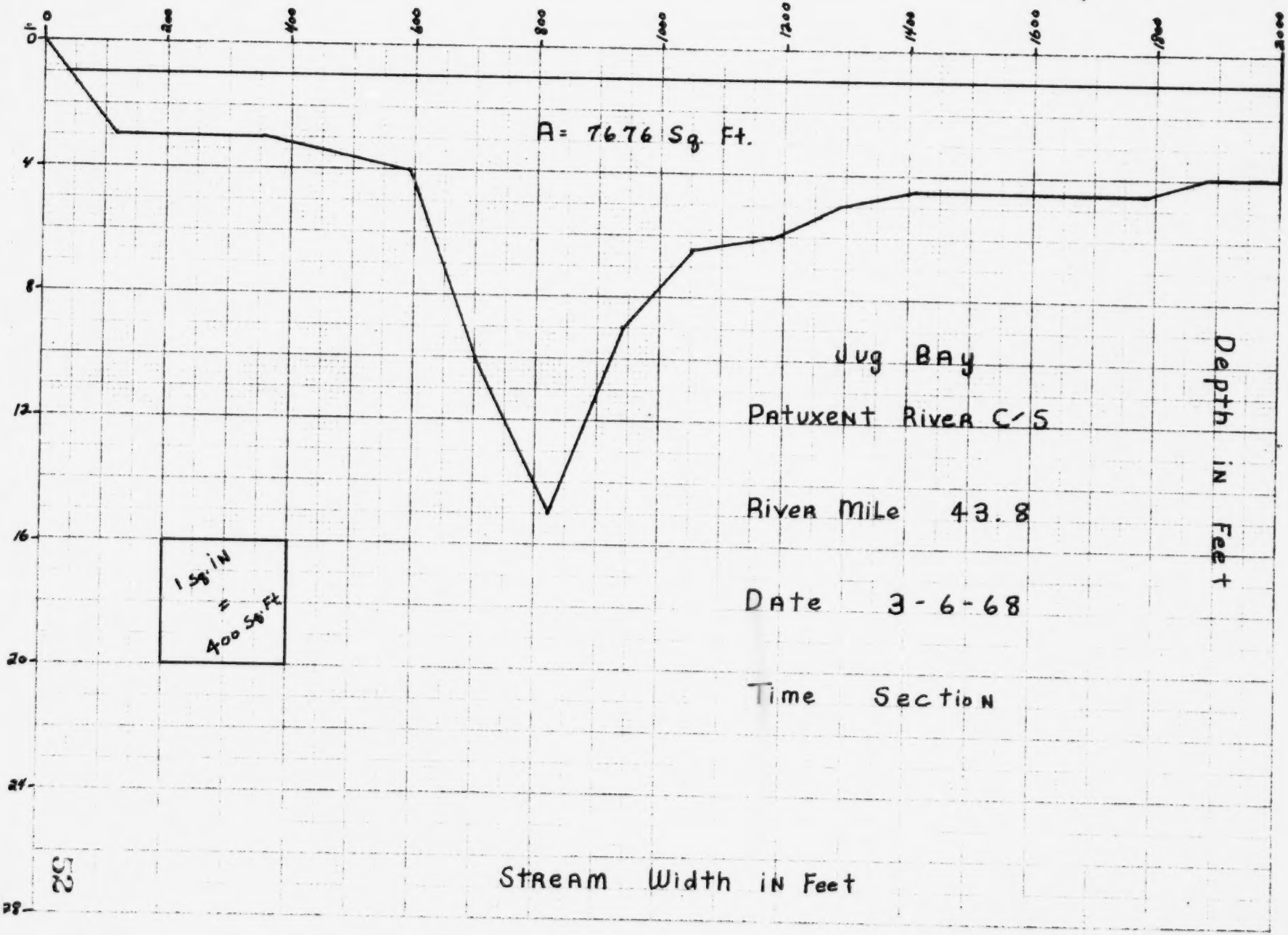

20 X 20 TO THE INCH 46 1240
0
100
200
300
400
500
600
700
800
900
1000
5
10
15
20
25
30
35
40
45
50
55
60
65
70
A = 7773 Sq. Ft.
1 Sq. in = 250 Sq. Ft.
Patuxent River C-S
River Mile 41.8
Date 3-7-68
Time Section
Depth in Feet
Stream Width in Feet

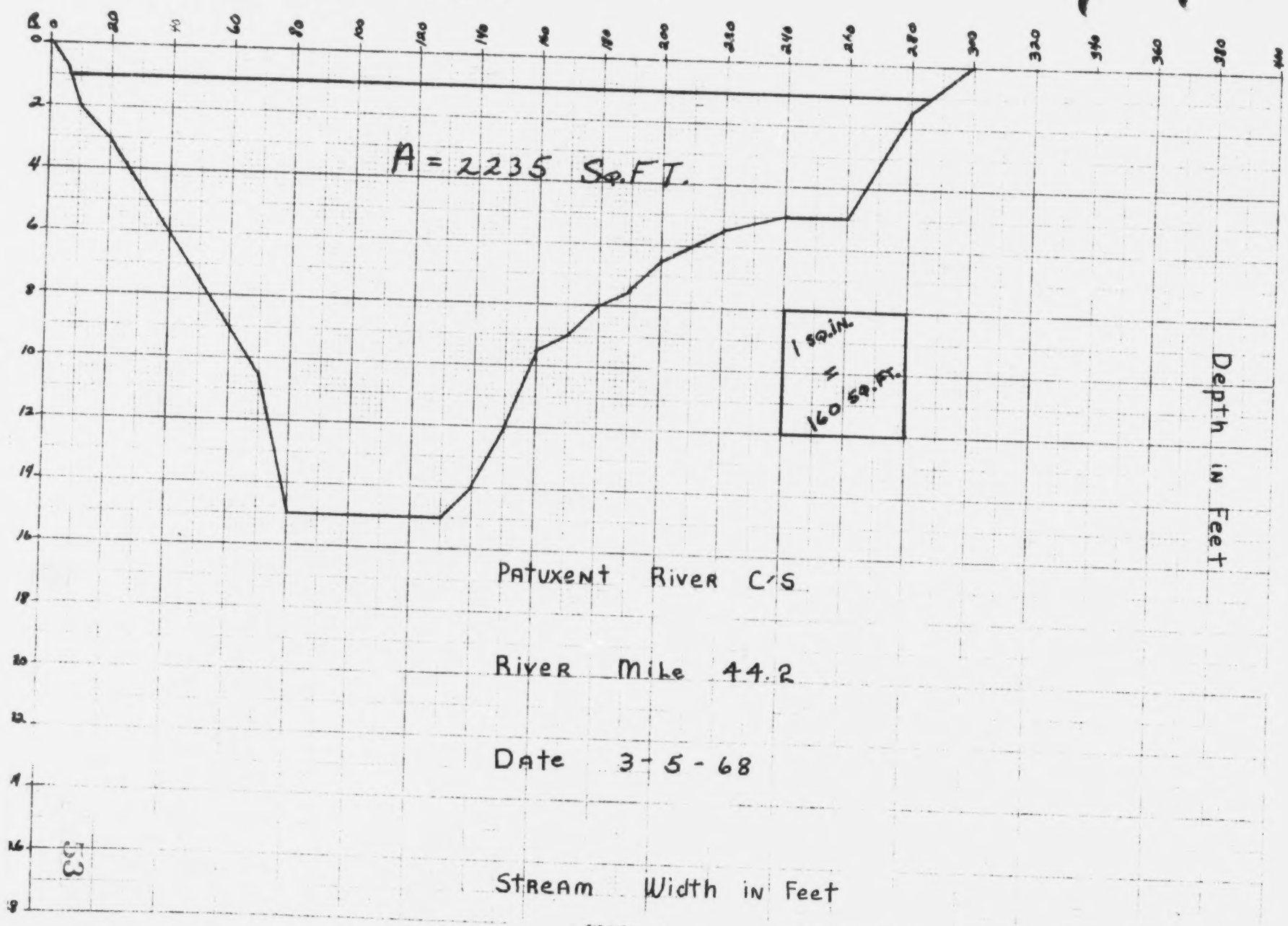

A = 4708 Sq. Ft.
1 SQ. IN. = 160 SQ. FT.
Depth in Feet
River Mile
42.6
Jug Bay
Patuxent River
C-S
Date 3-6-68
Stream Width in Feet


A = 7600 Sq. Ft.
Patuxent River C'S
1 SQ.IN. = 400 SQ. FT.
Depth in Feet
Date 3-6-68
River Mile 43.0
Time Section
Stream Width in Feet

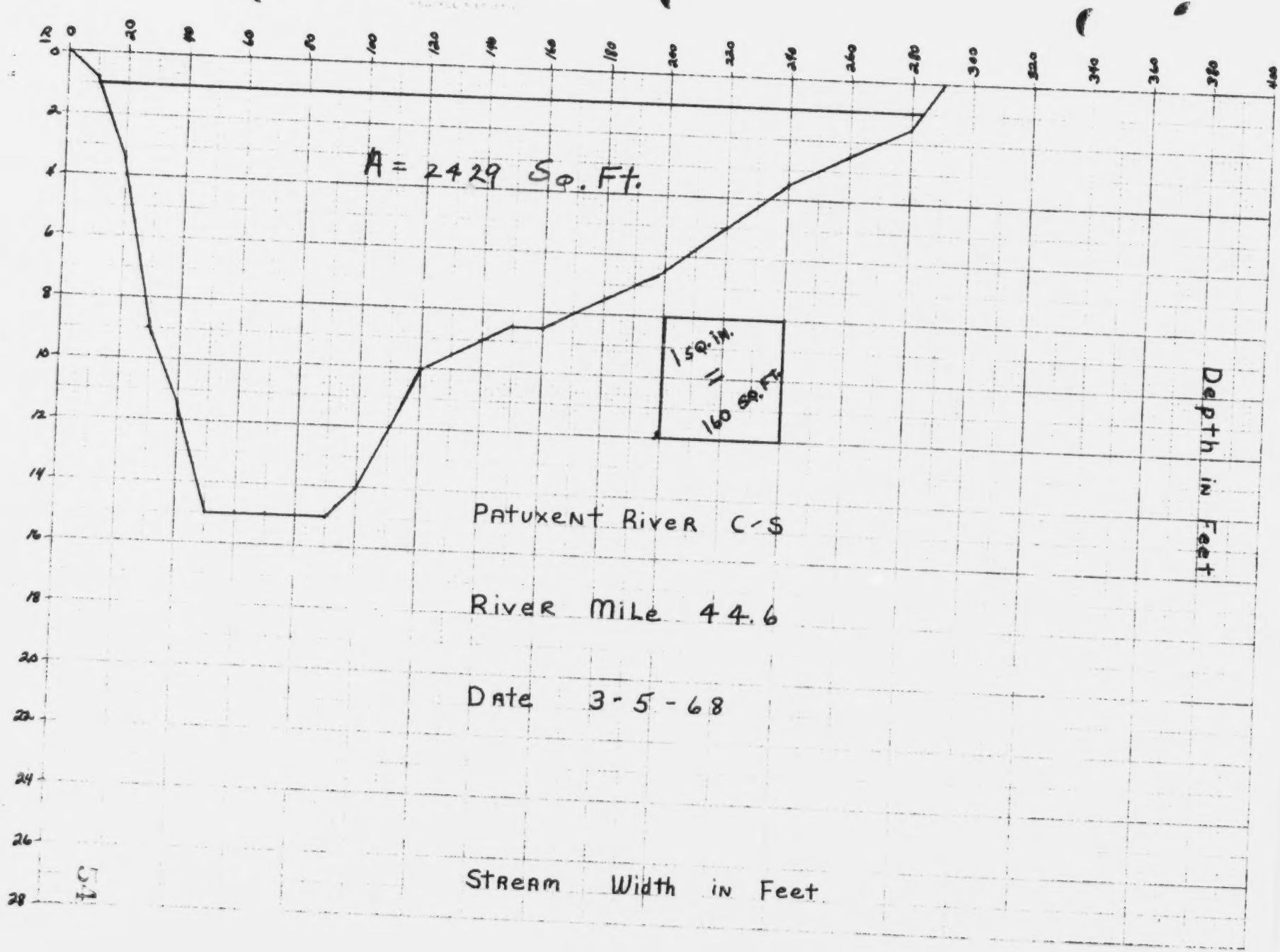
20 X 20 TO THE INCH 46 1240




0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
4
8
12
16
20
24
28
A= 7676 Sq. Ft.
1 Sq. IN = 400 Sq. Ft.
Jug Bay
Patuxent River C/S
River Mile 43.8
Date 3-6-68
Time Section
Depth IN Feet
Stream Width IN Feet


A = 2235 Sq.FT.
1 sq.in. = 160 sq.ft.
Depth in Feet
Patuxent River C/S
River Mile 44.2
Date 3-5-68
Stream Width in Feet

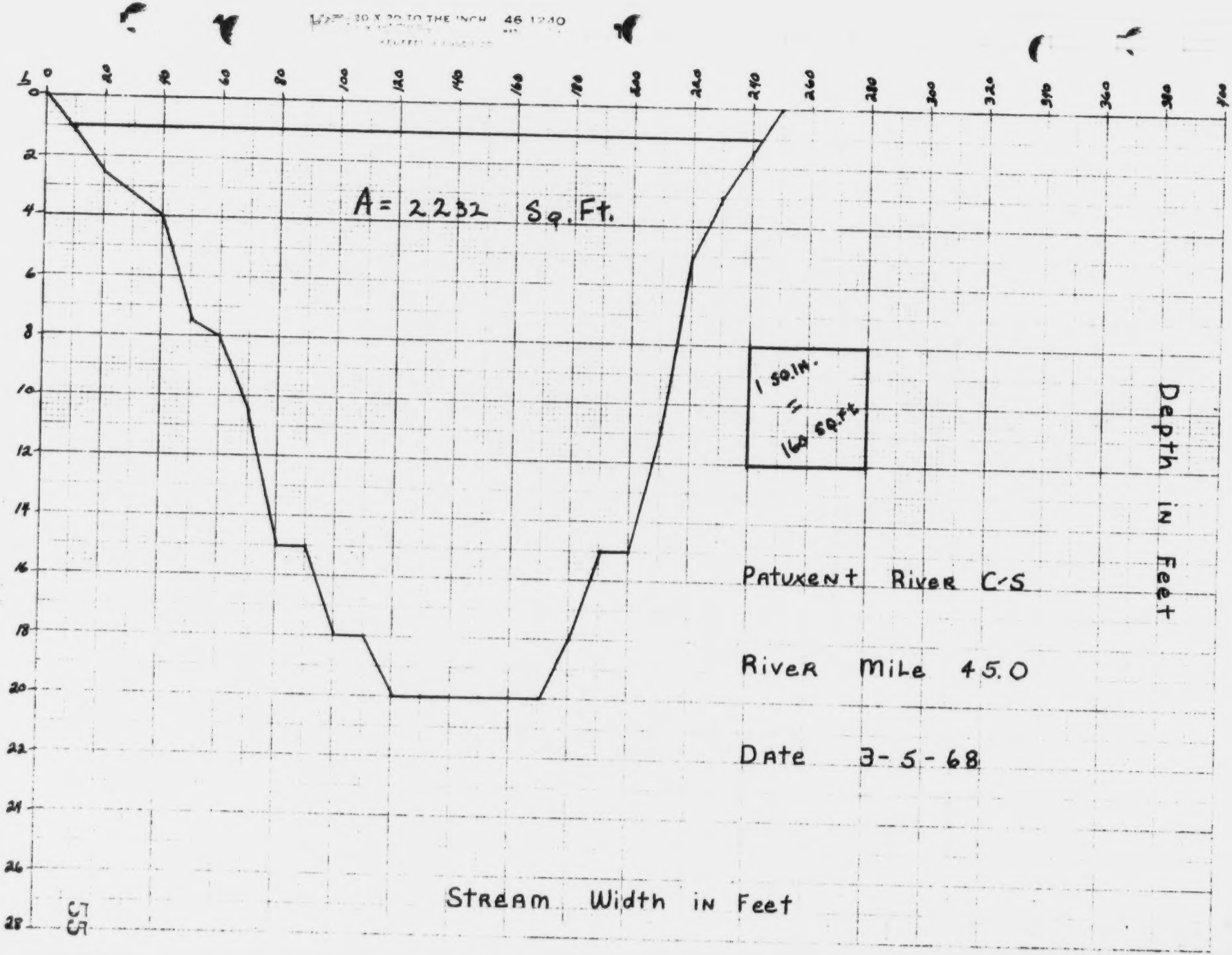
20 X 20 TO THE INCH 46 1240

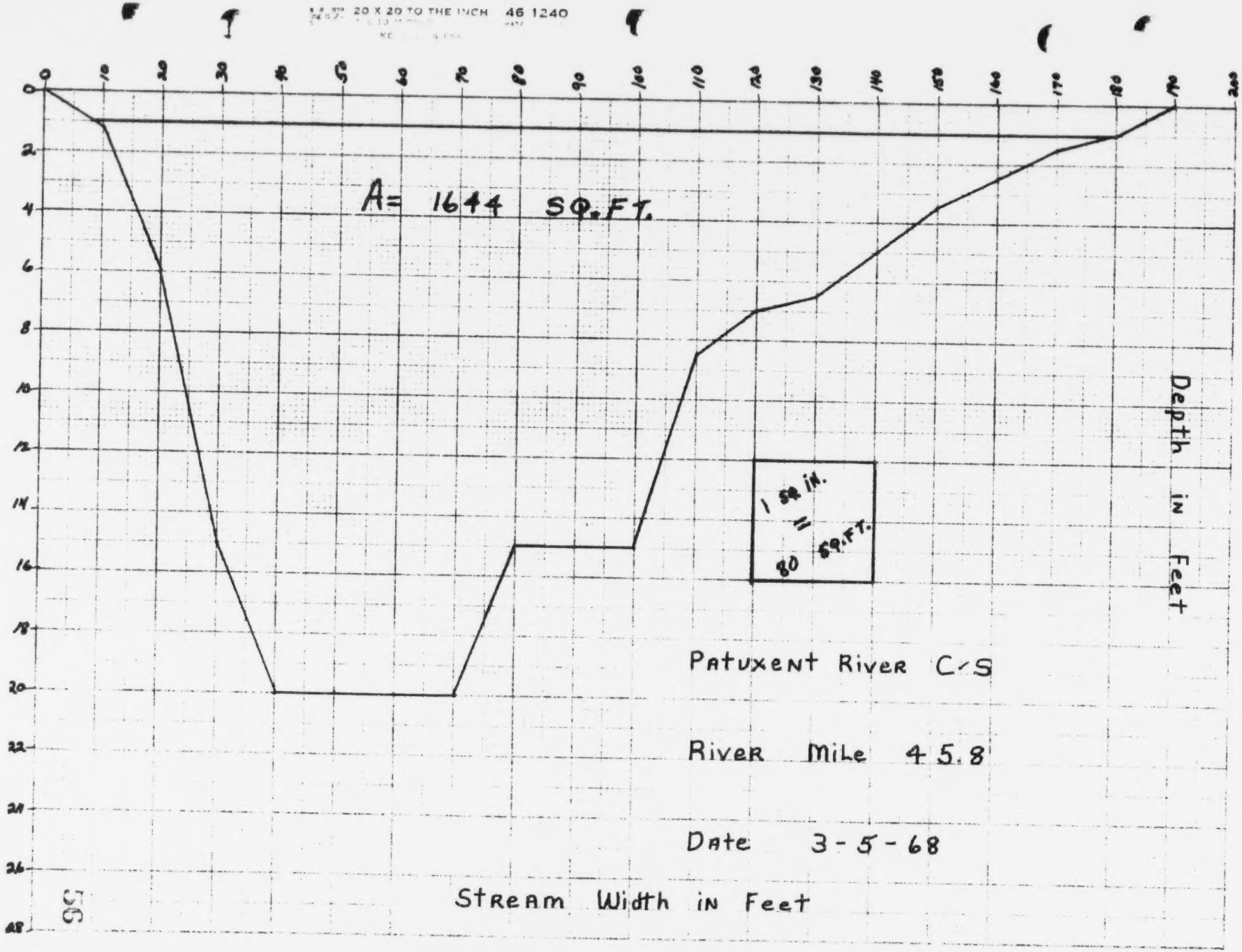


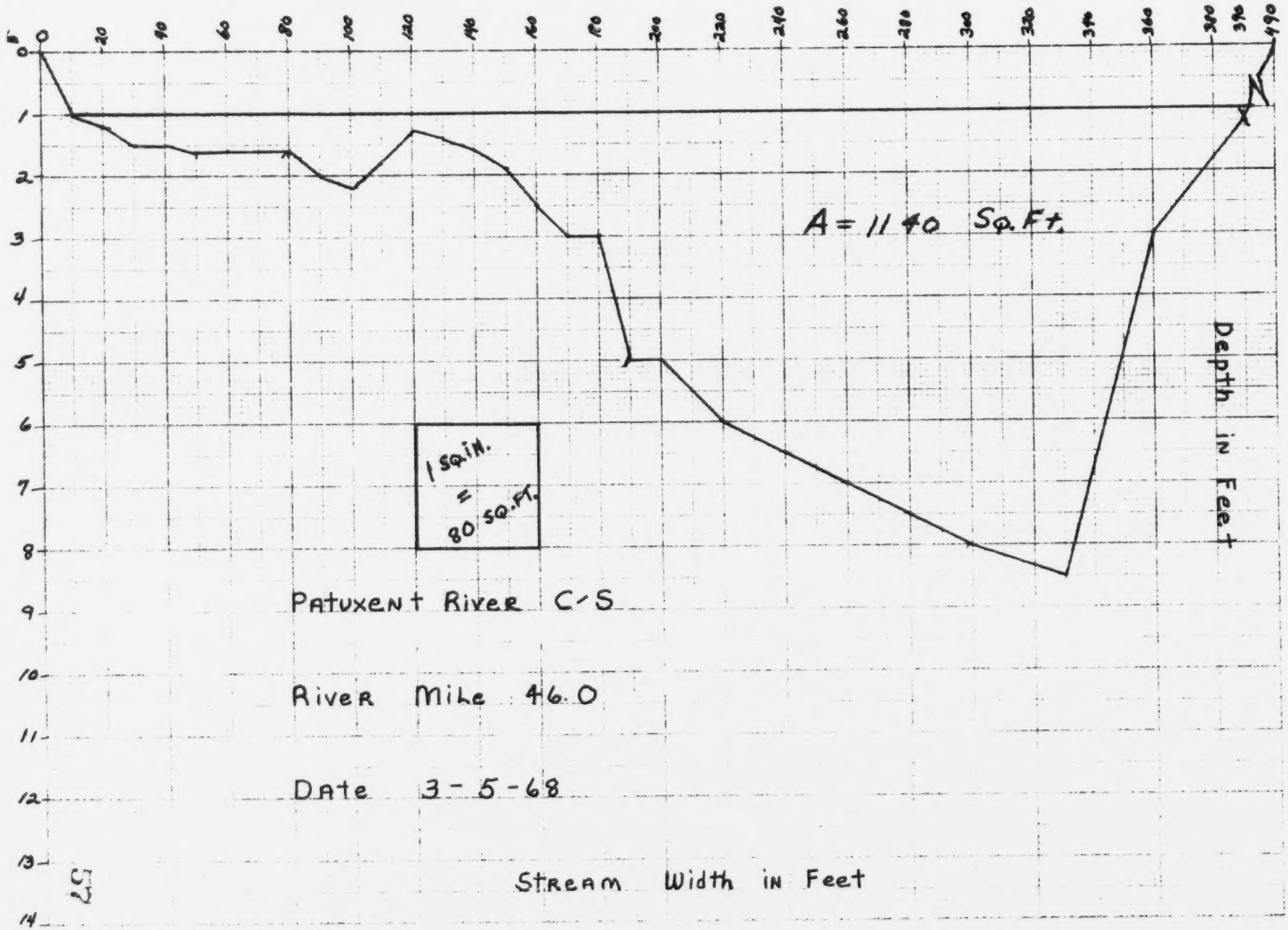
Patuxent River C-S

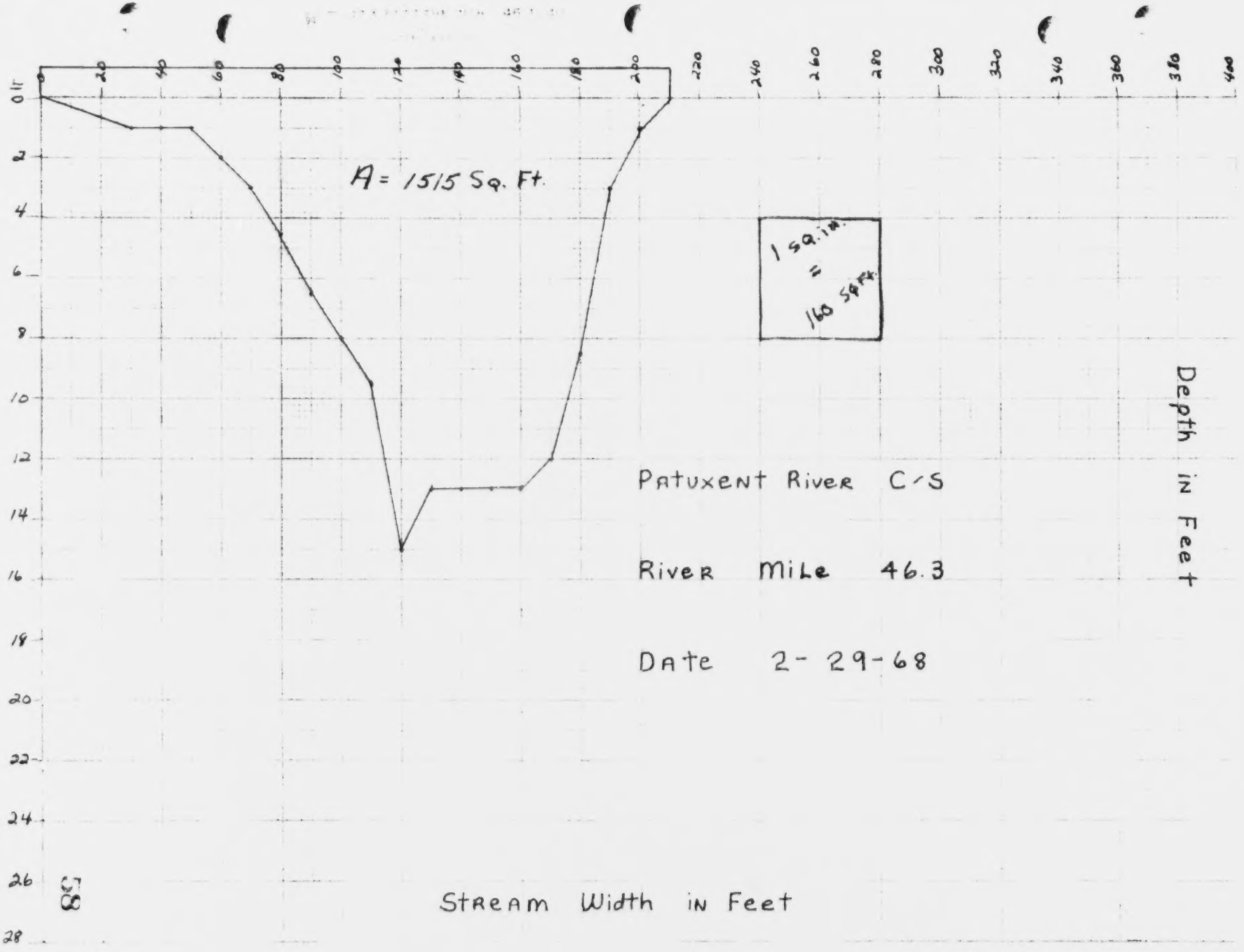
River Mile 44.6

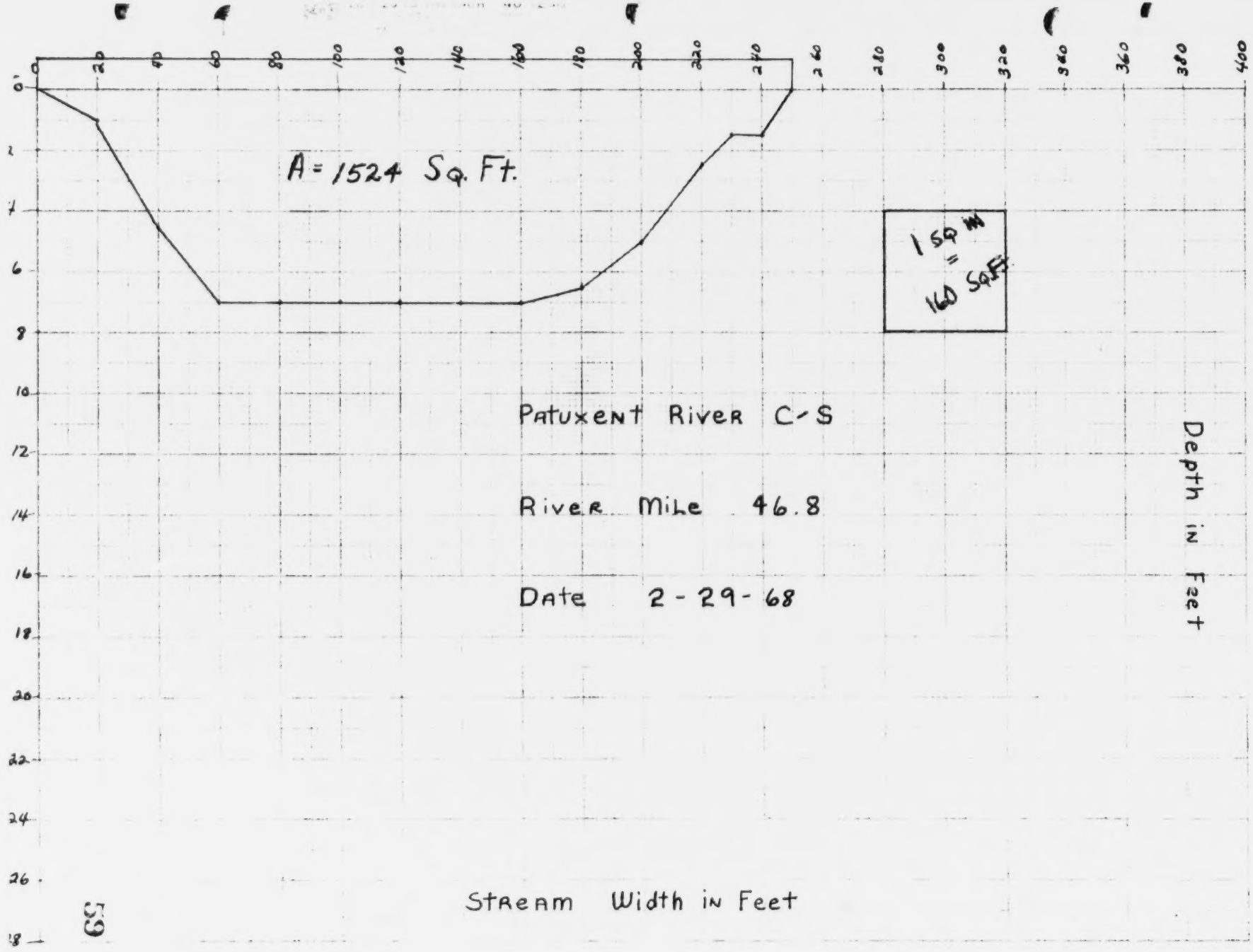
Date 3-5-68

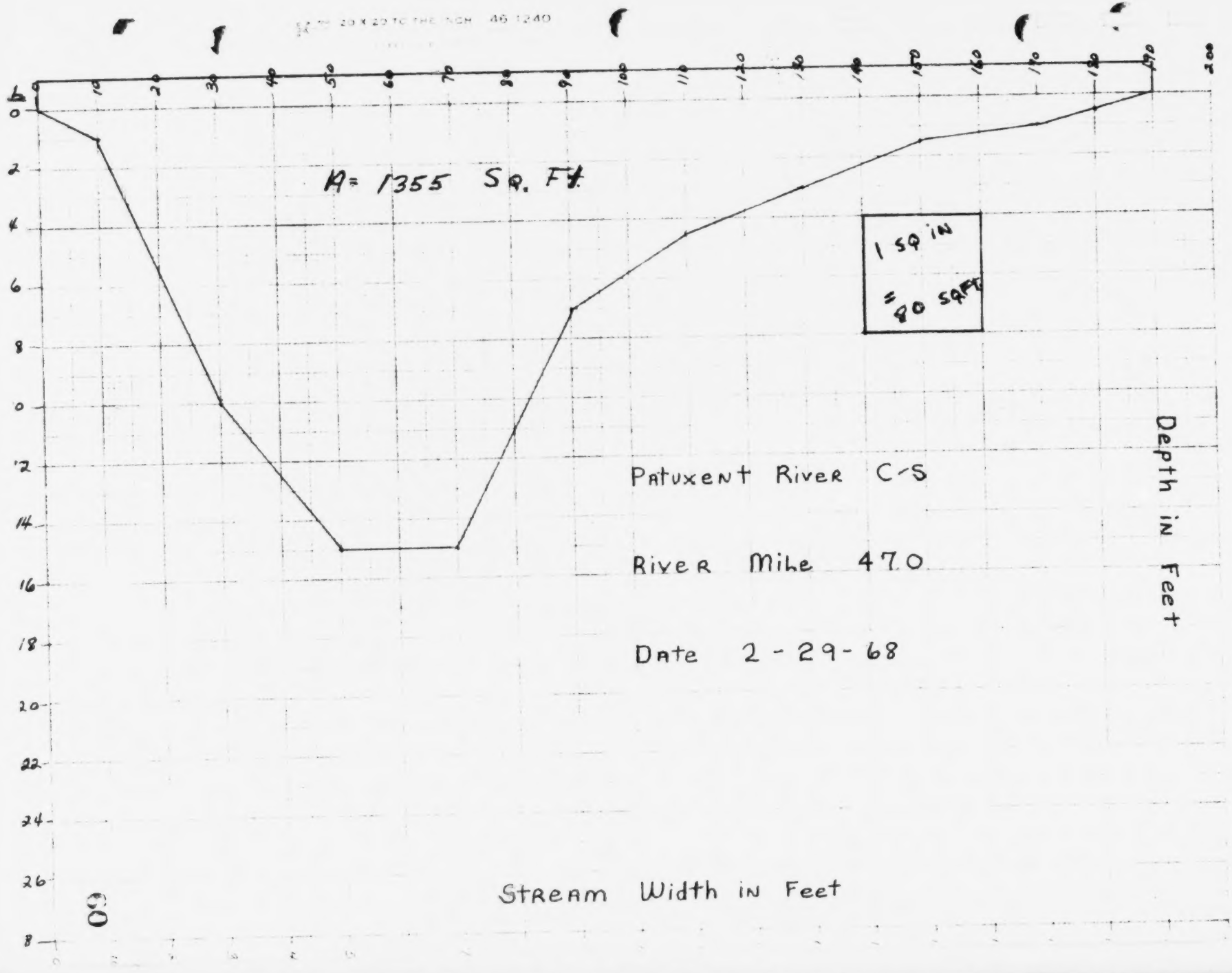

A = 2232 Sq. Ft.
1 SQ.IN. = 16 SQ.FT.
Patuxent River C-S
River Mile 45.0
Date 3-5-68
Depth in Feet
Stream Width in Feet

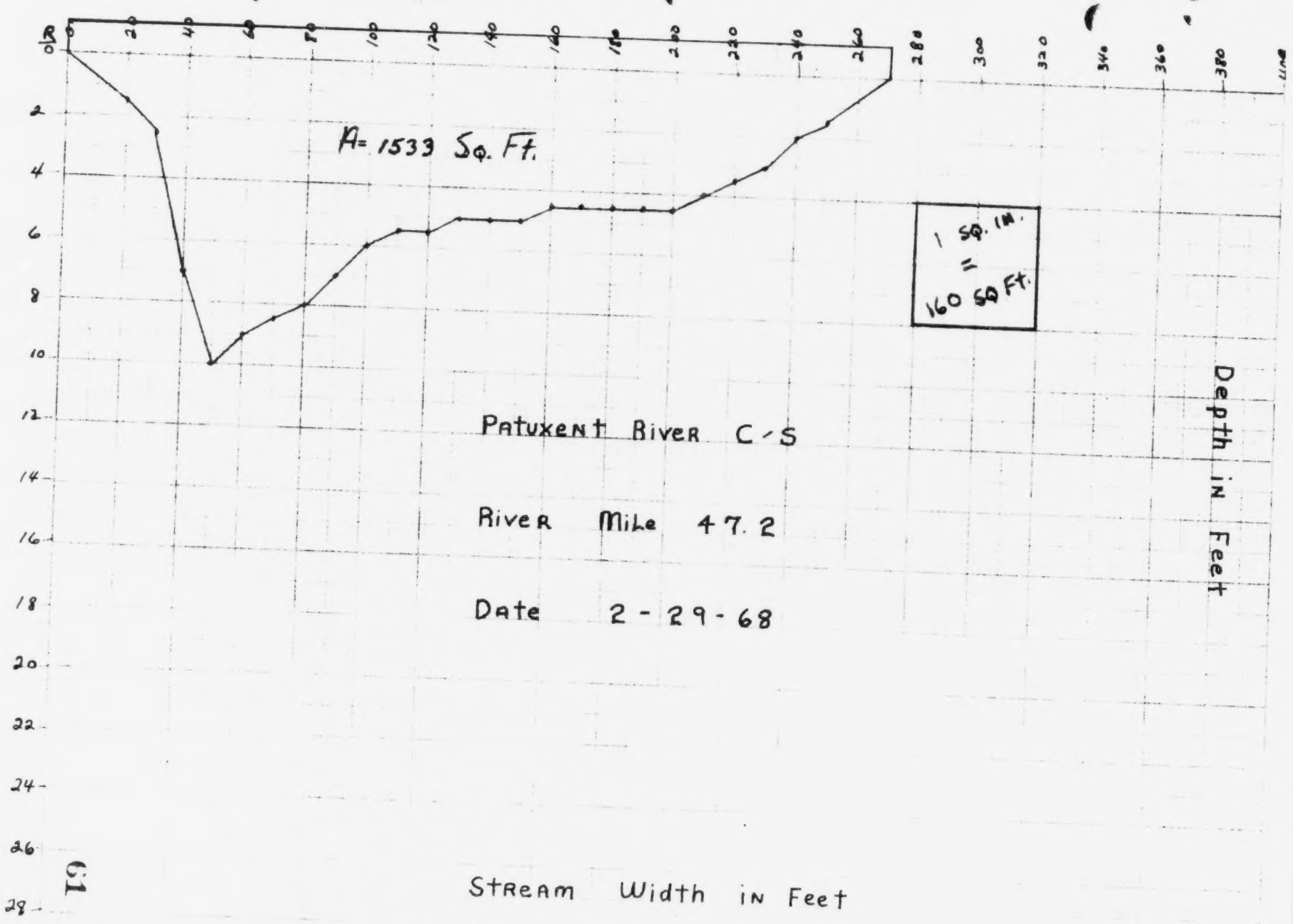

20 X 20 TO THE INCH 46 1240
A= 1644 SQ.FT.
1 SQ IN. = 80 SQ.FT.
Depth in Feet
Patuxent River C-S
River Mile 45.8
Date 3-5-68
Stream Width in Feet

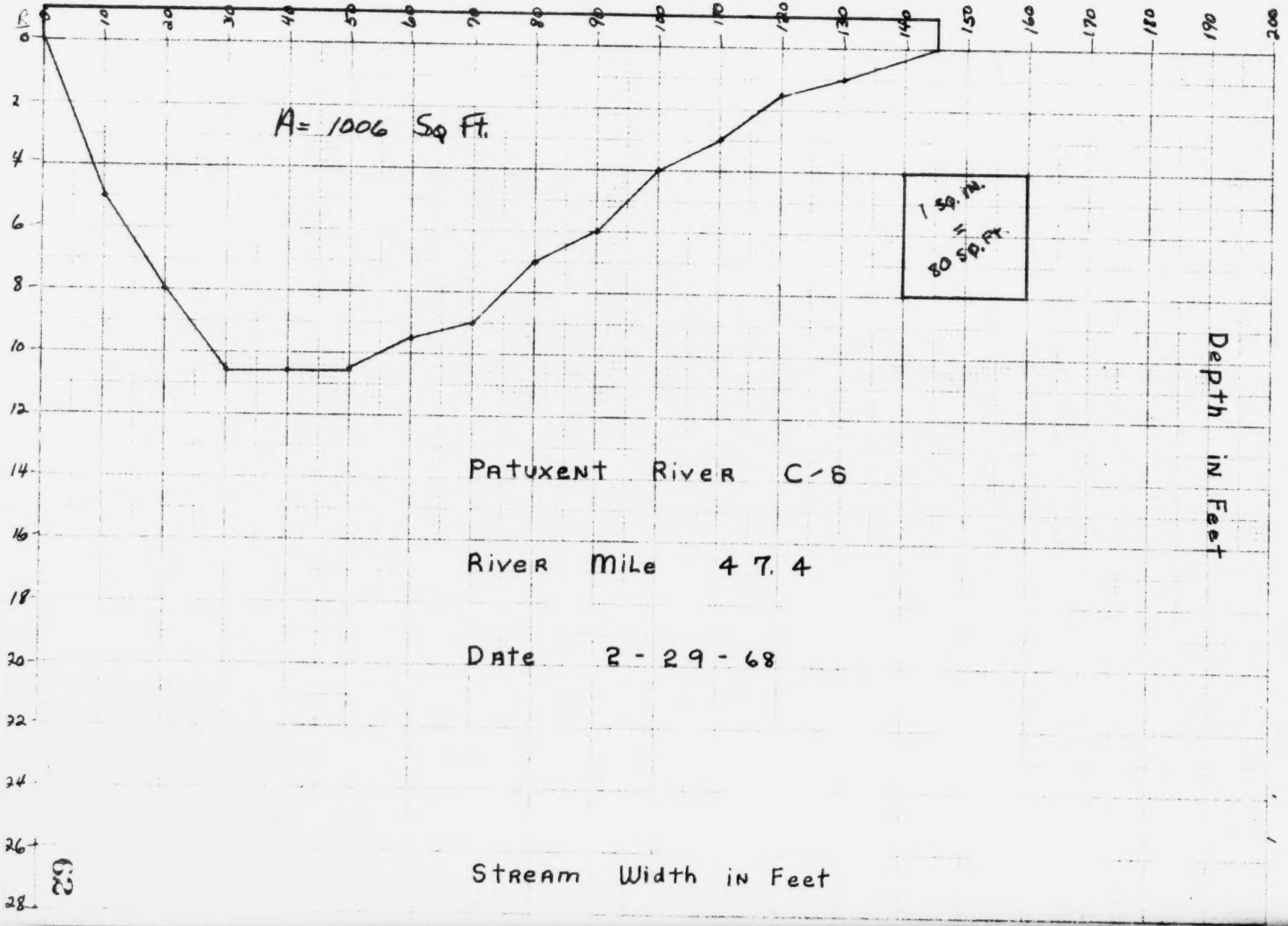

A = 1140 Sq. Ft.
1 Sq. In. = 80 Sq. Ft.
Depth in Feet
Patuxent River C-S
River Mile 46.0
Date 3-5-68
Stream Width in Feet

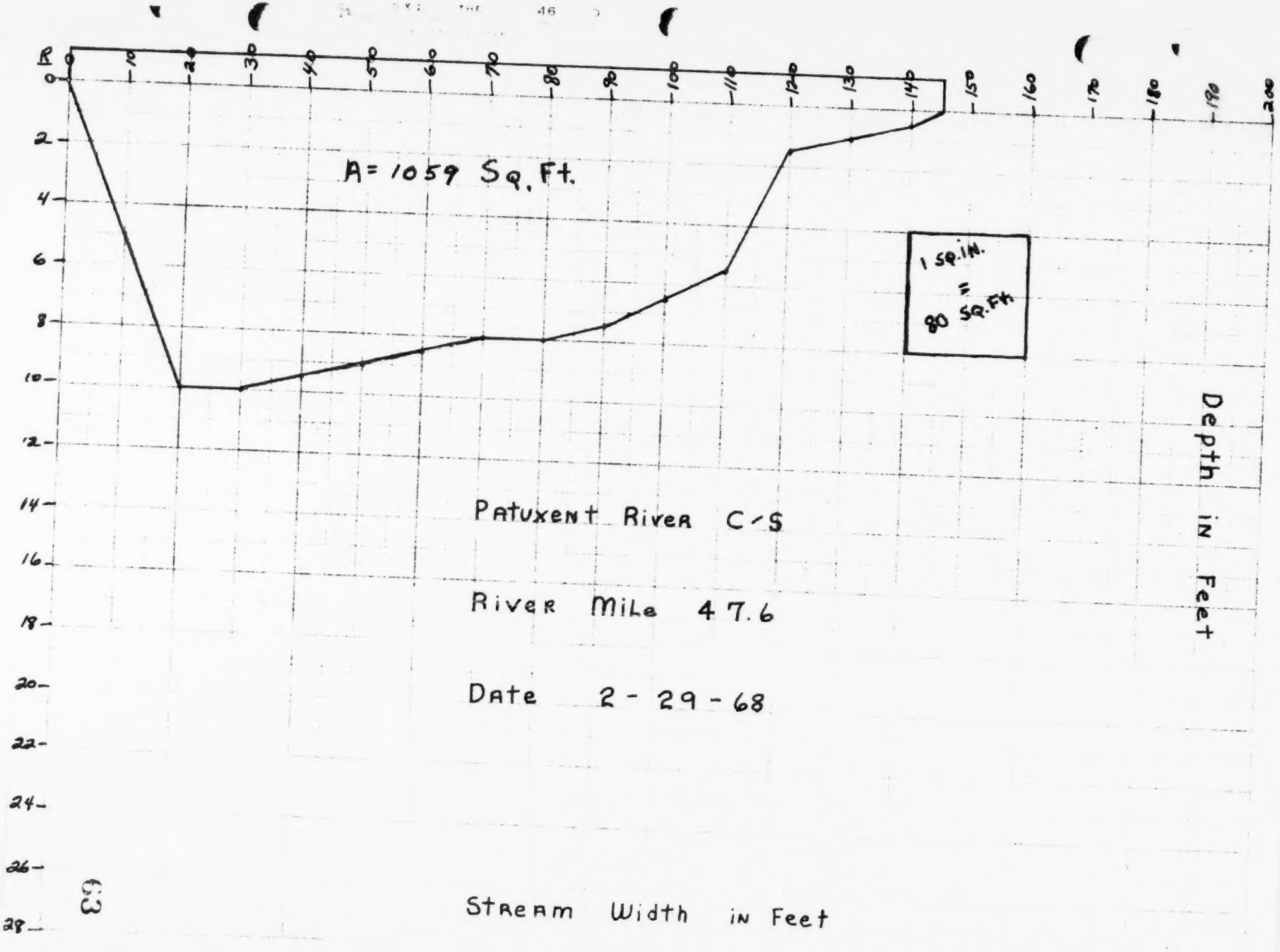

A = 1515 Sq. Ft.
1 sq. in. = 160 Sq. Ft.
Patuxent River C-S
River Mile 46.3
Date 2-29-68
Depth in Feet
Stream Width in Feet

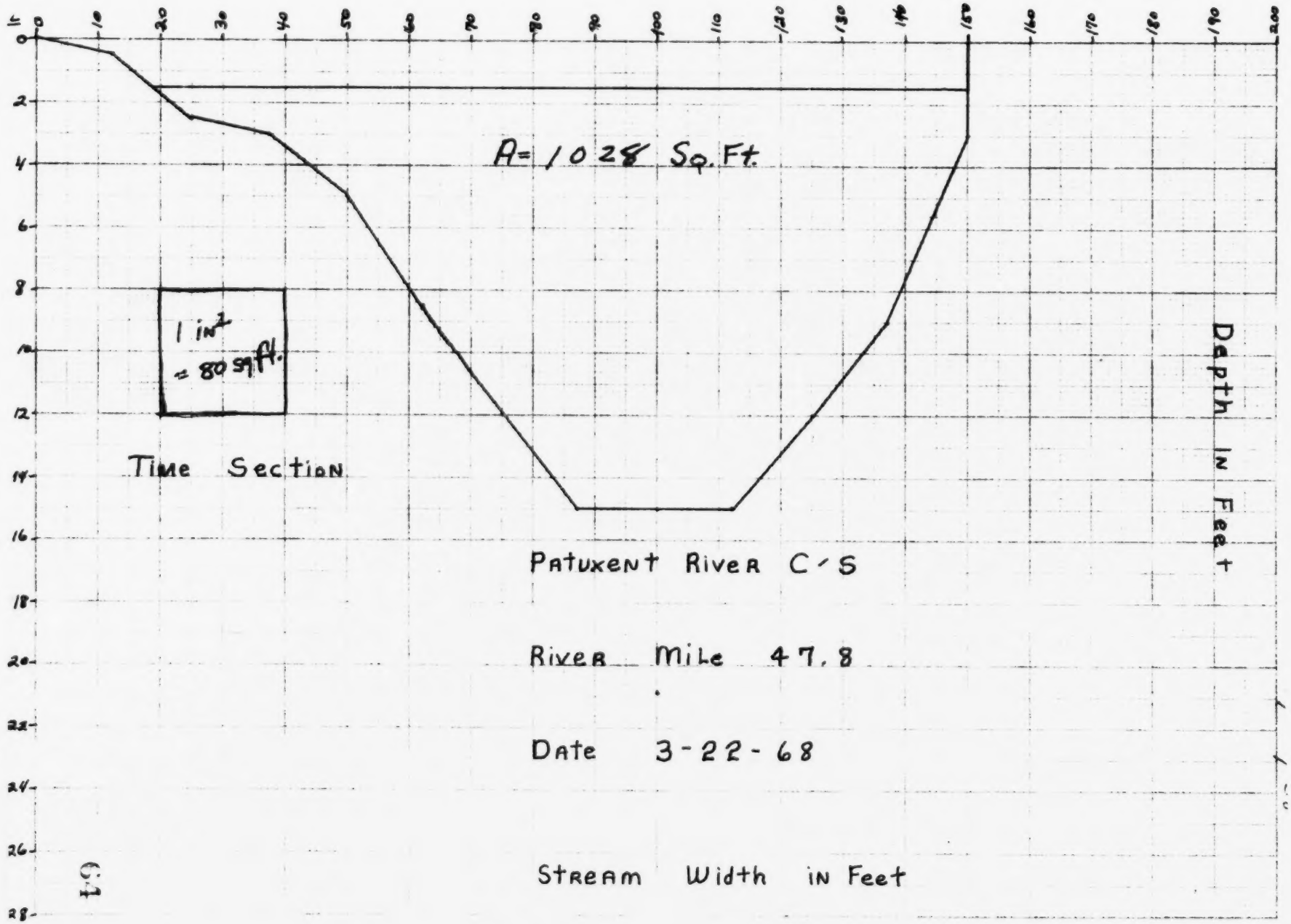

A = 1524 Sq. Ft.
150 ft = 160 Sq Ft
Patuxent River C-S
River Mile 46.8
Date 2-29-68
Depth in Feet
Stream Width in Feet

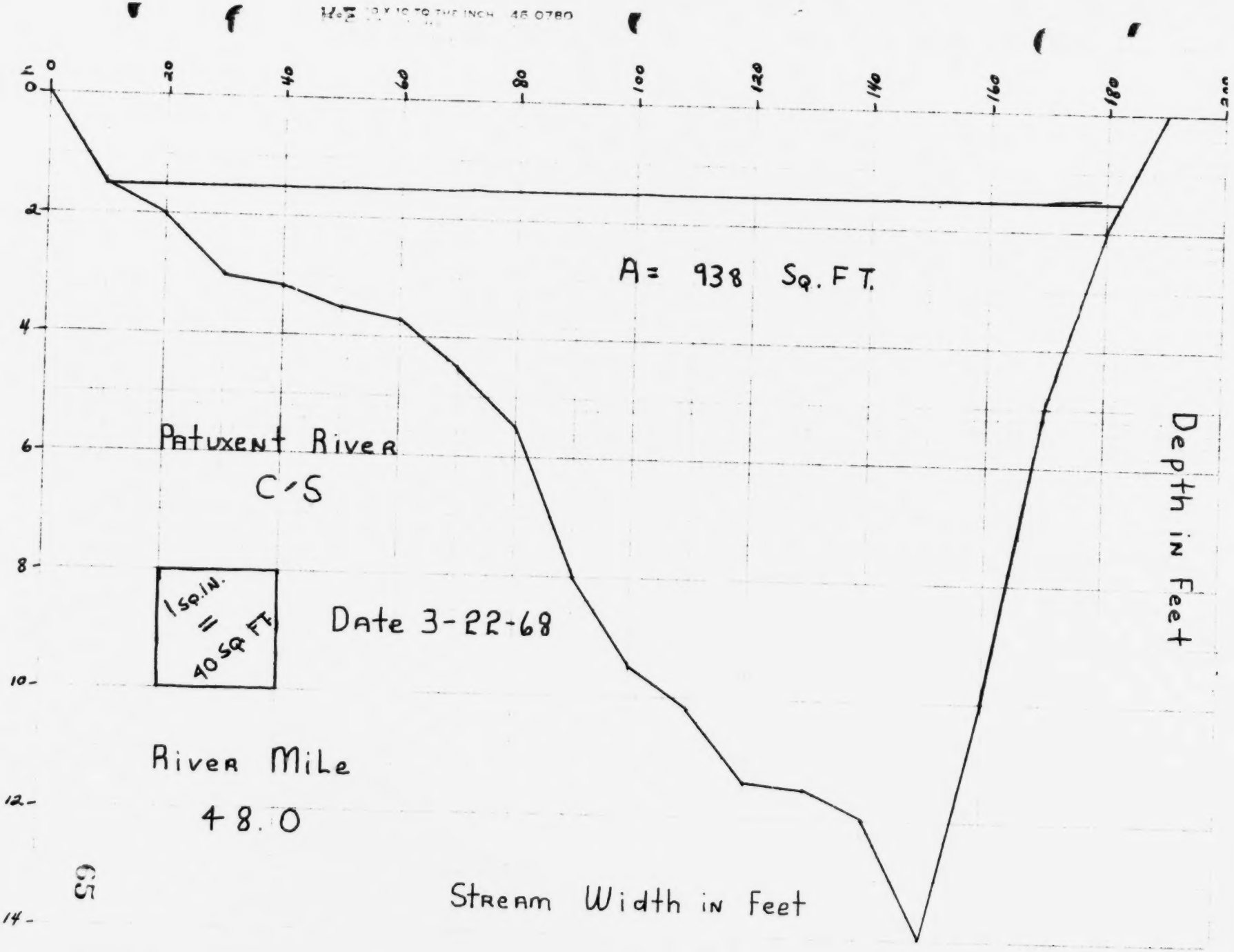

A= 1355 SQ. FT.
1 SQ IN
=40 SQFT
Patuxent River C-S
River Mile 47.0
Date 2-29-68
Depth in Feet
Stream Width in Feet

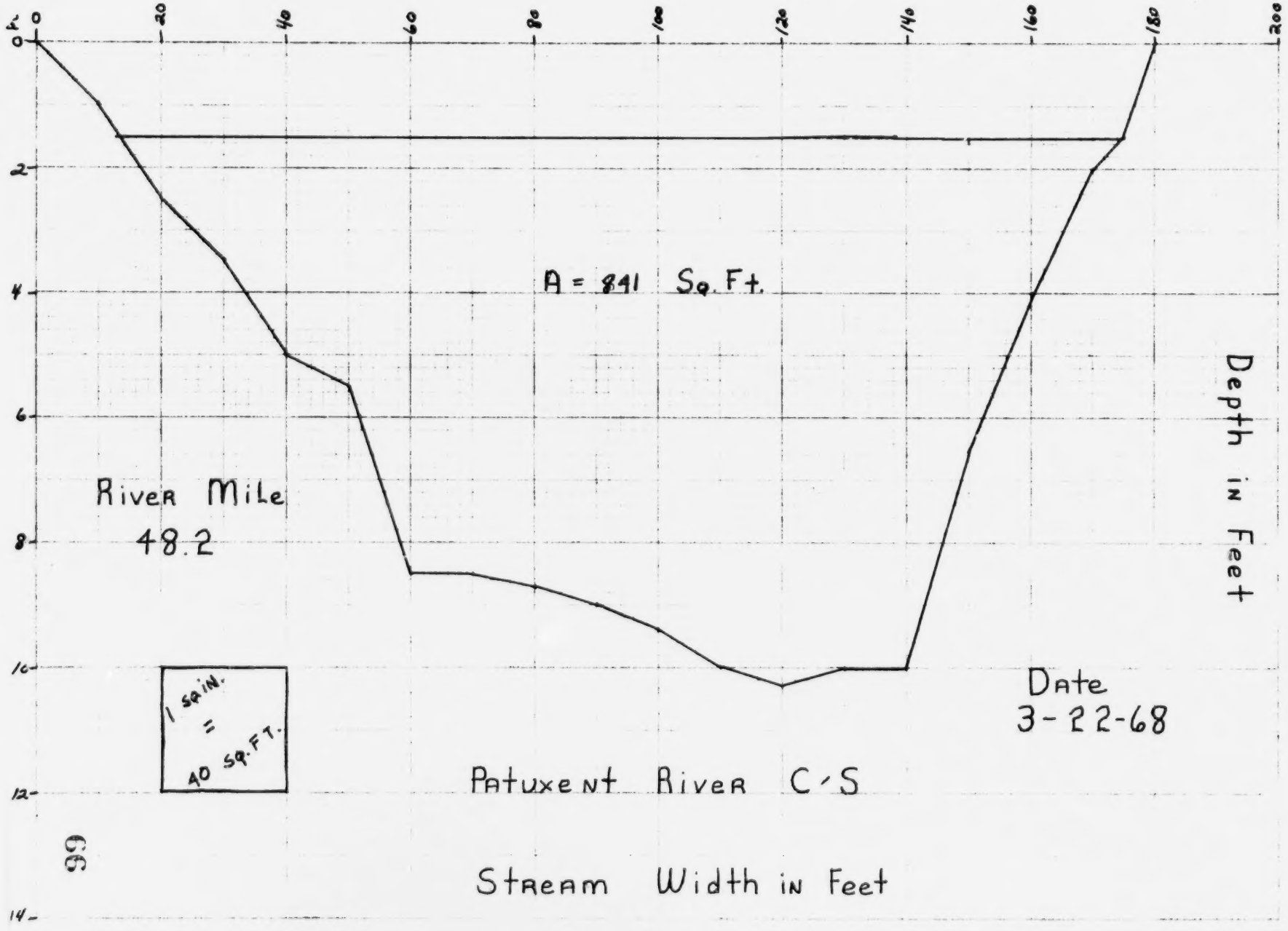

A= 1533 Sq. Ft.
1 Sq. In. = 160 Sq Ft.
Patuxent River C-S
River Mile 47.2
Date 2-29-68
Depth in Feet
Stream Width in Feet

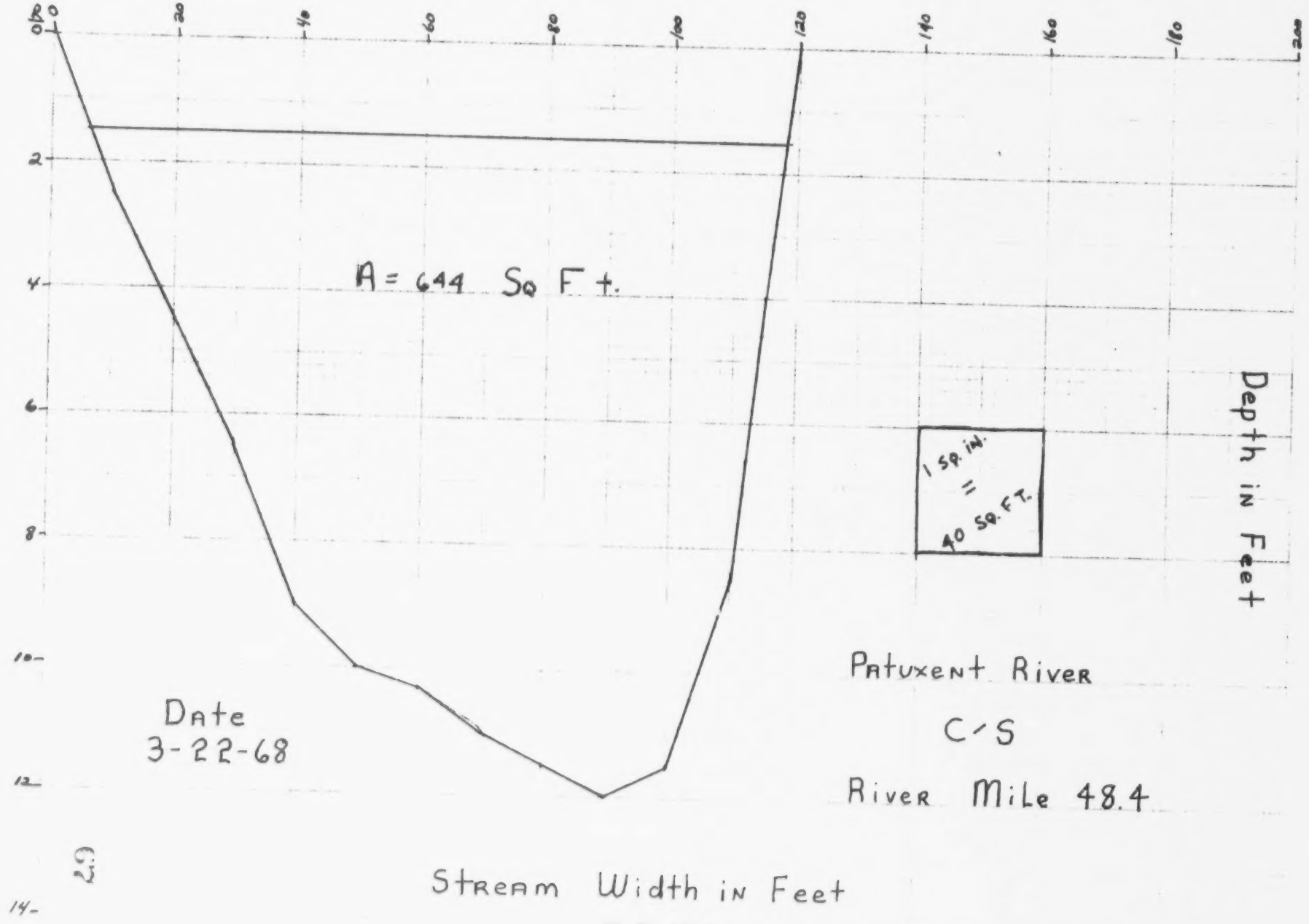

A= 1006 Sq Ft.
1 Sq. In. = 80 Sq. Ft.
Patuxent River C-6
River Mile 47.4
Date 2-29-68
Depth in Feet
Stream Width in Feet

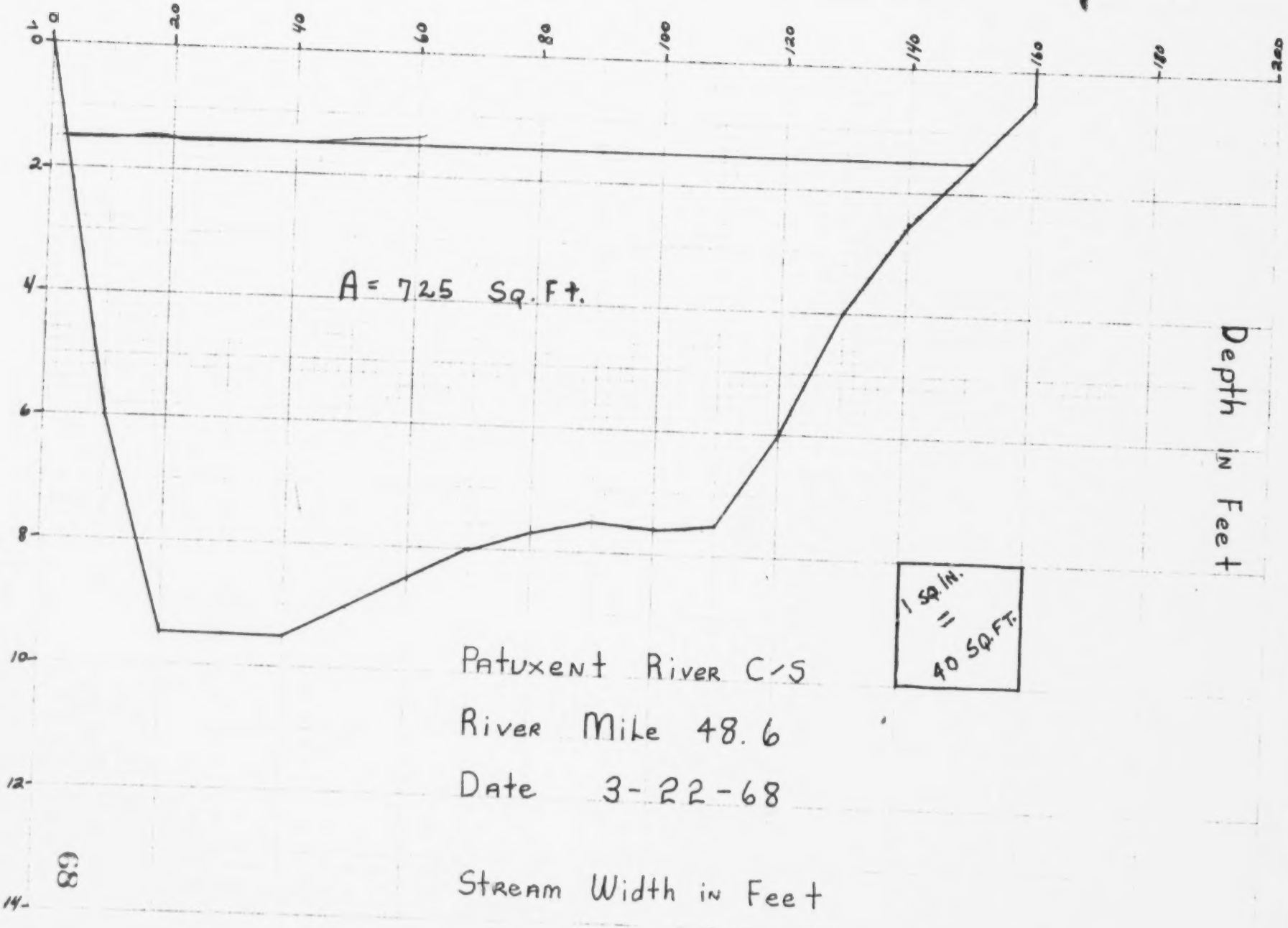

A= 1059 Sq. Ft.
1 SQ. IN. = 80 SQ. FT.
Patuxent River C-S
River Mile 47.6
Date 2-29-68
Depth in Feet
Stream Width in Feet

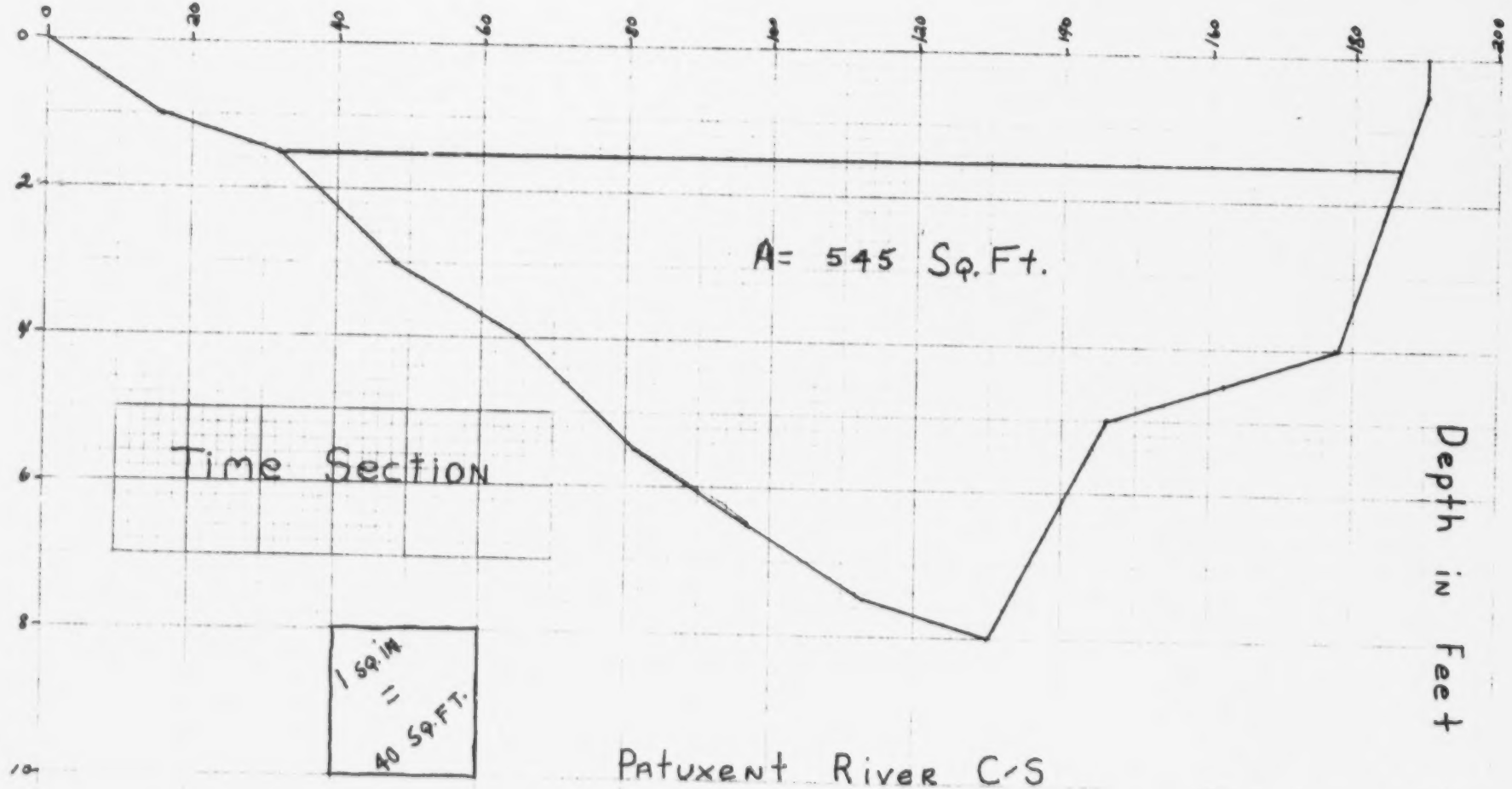

A= 1028 Sq. Ft.
1 in² = 80 sq ft.
Time Section
Depth in Feet
Patuxent River C-S
River Mile 47.8
Date 3-22-68
Stream Width in Feet


0
20
40
60
80
100
120
140
160
180
2
4
6
8
10
12
14
A= 938 Sq. F T.
Patuxent River
C/S
1 SQ.IN. = 40 SQ FT.
Date 3-22-68
River Mile
48.0
Stream Width in Feet
Depth in Feet


0
20
40
60
80
100
120
140
160
180
200
0
2
4
6
8
10
12
14
A = 841 Sq. Ft.
River Mile
48.2
1 sq in. = 40 sq. ft.
Date
3-22-68
Patuxent River C'S
Stream Width in Feet
Depth in Feet


0
20
40
60
80
100
120
140
160
180
200
2
4
6
8
10
12
14
A = 644 Sq Ft.
1 Sq. In. = 40 Sq. Ft.
Depth in Feet
Date
3-22-68
Patuxent River
C/S
River Mile 48.4
Stream Width in Feet

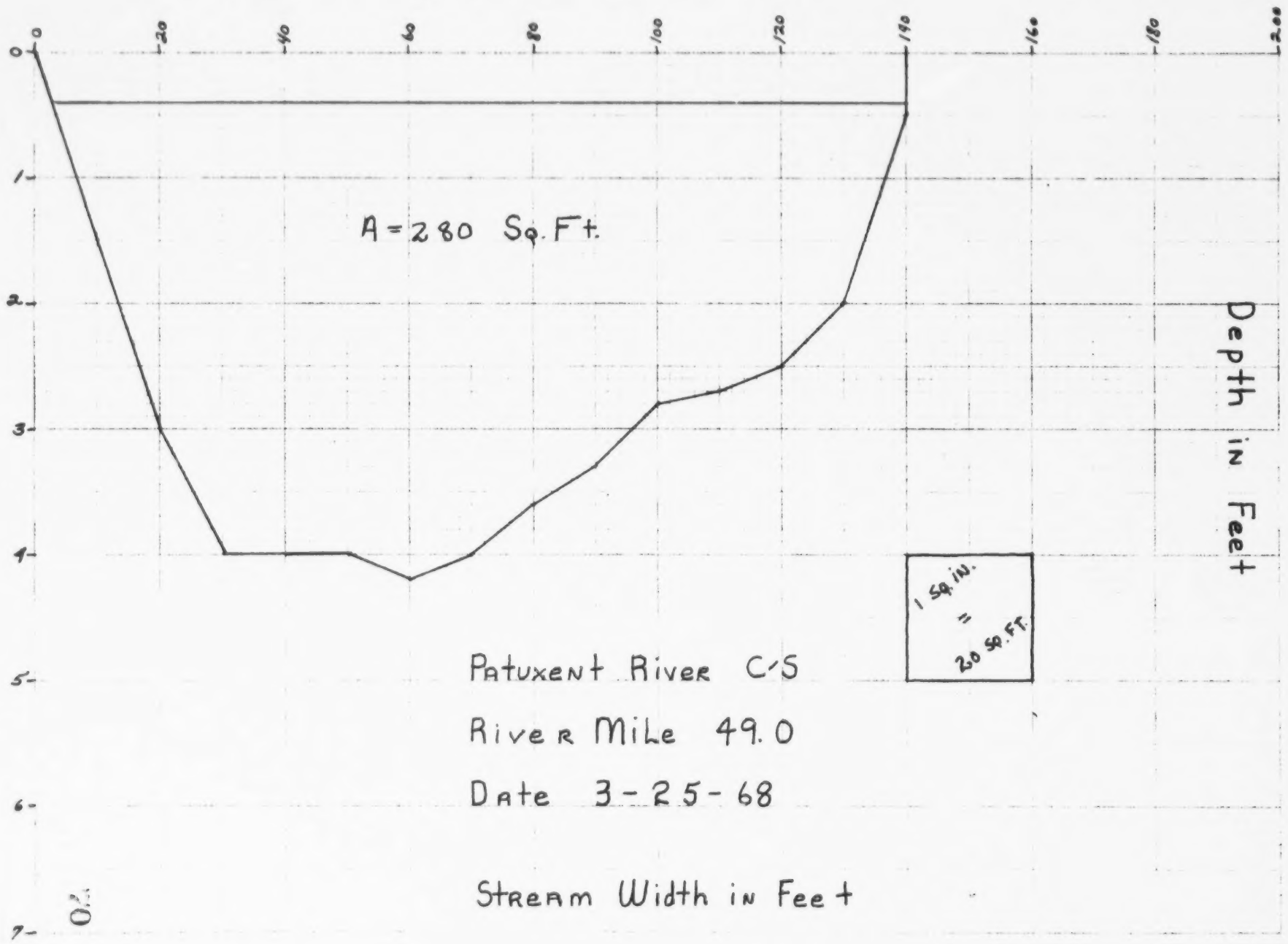

KOE 10 X 10 TO THE INCH 46 0780
0
20
40
60
80
100
120
140
160
180
200
2
4
6
8
10
12
14
A = 725 Sq. Ft.
Depth in Feet
1 SQ. IN. = 40 SQ. FT.
Patuxent River C/S
River Mile 48.6
Date 3-22-68
Stream Width in Feet

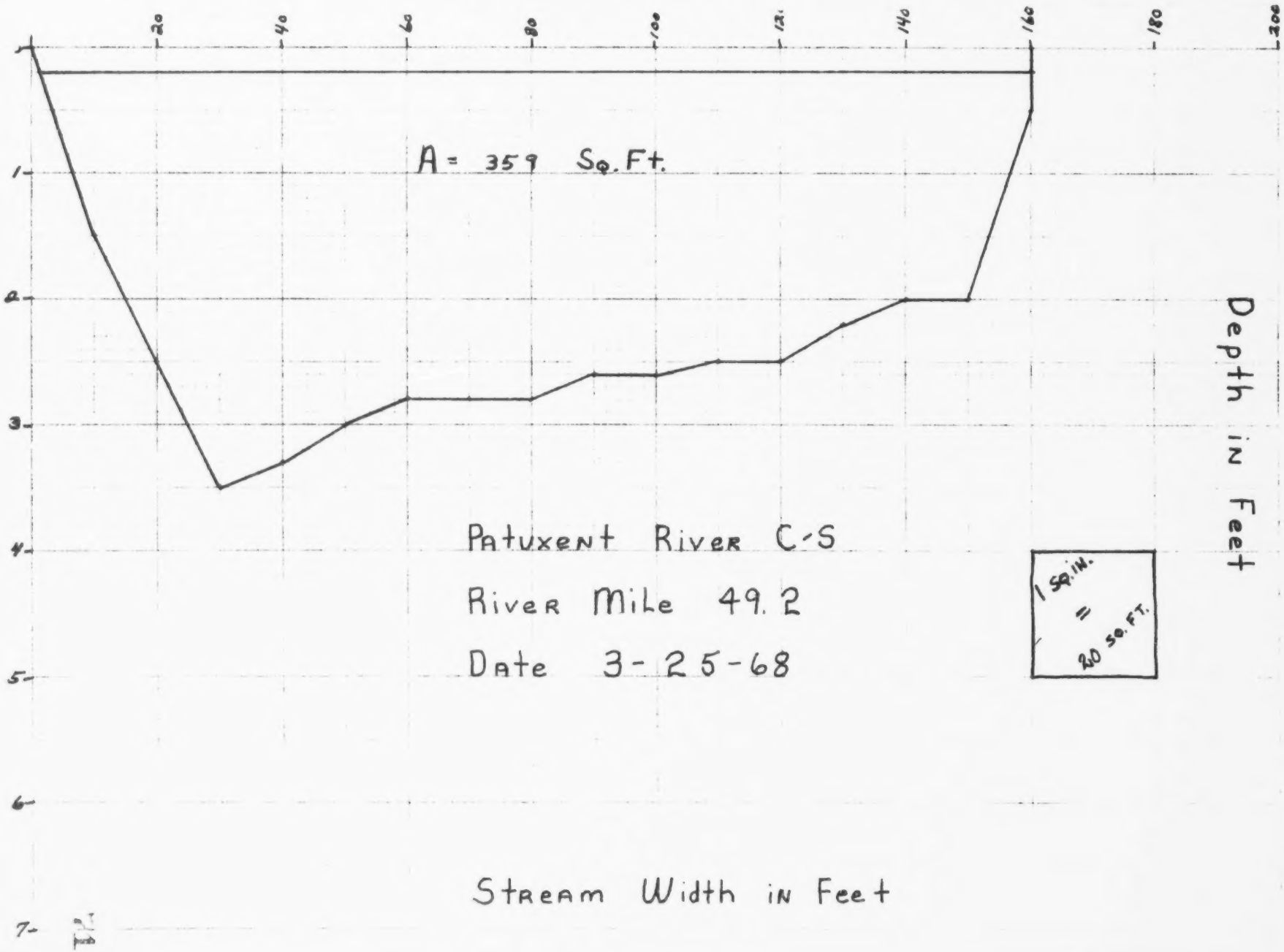


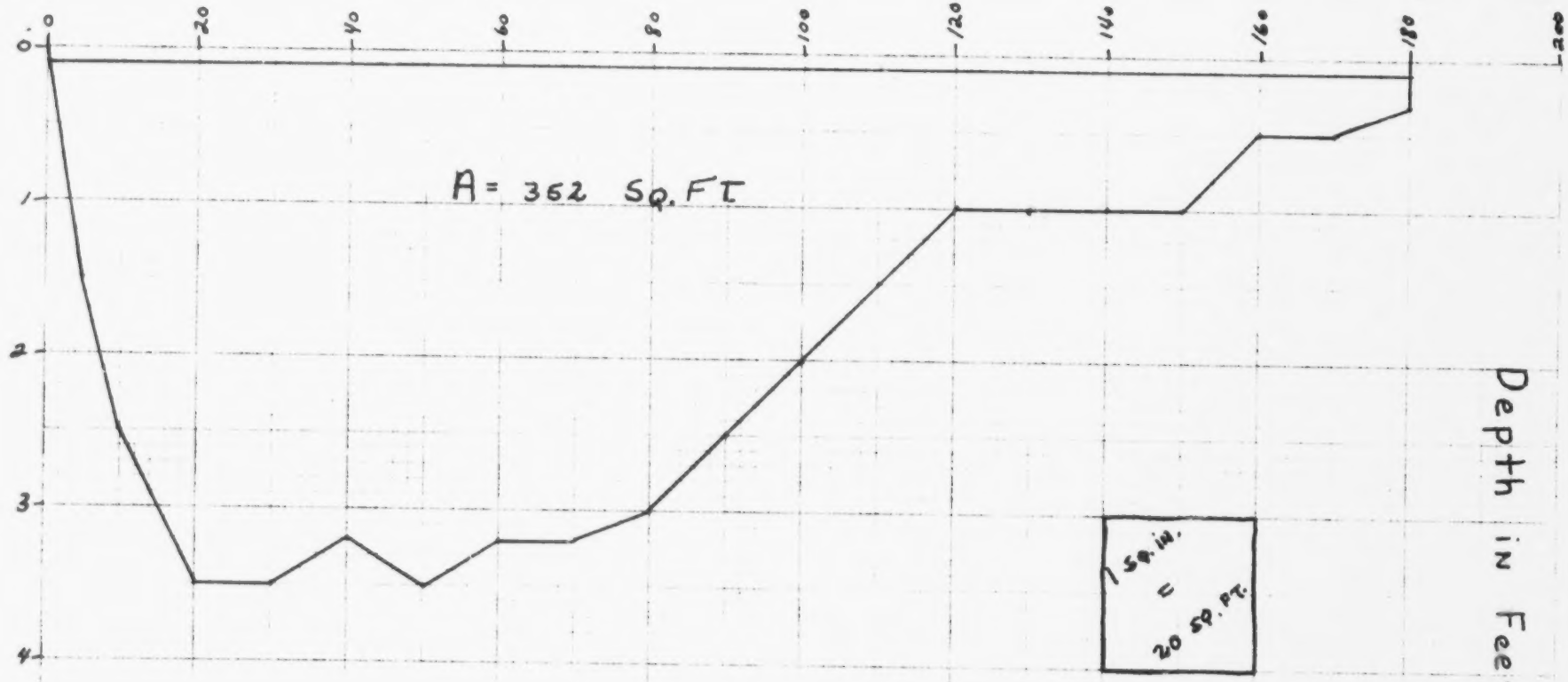
Patuxent River C-S

River Mile 48.8

Date 3-22-68


0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
A = 280 Sq. Ft.
Depth in Feet
1 Sq. in. = 20 Sq. Ft.
Patuxent River C/S
River Mile 49.0
Date 3-25-68
Stream Width in Feet

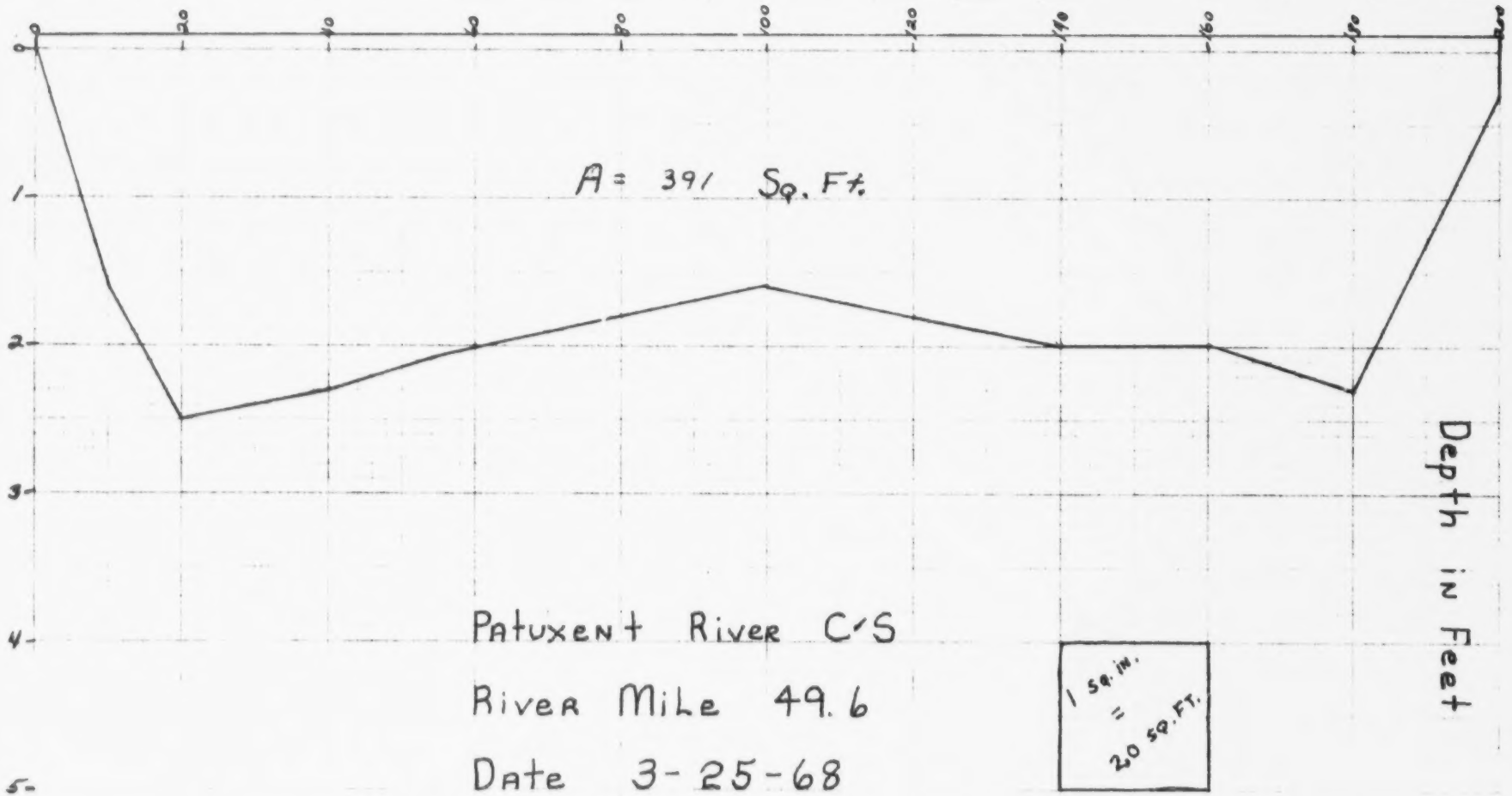

20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
A = 359 Sq. Ft.
Patuxent River C-S
River Mile 49.2
Date 3-25-68
1 Sq. IN. = 20 Sq. FT.
Depth in Feet
Stream Width in Feet

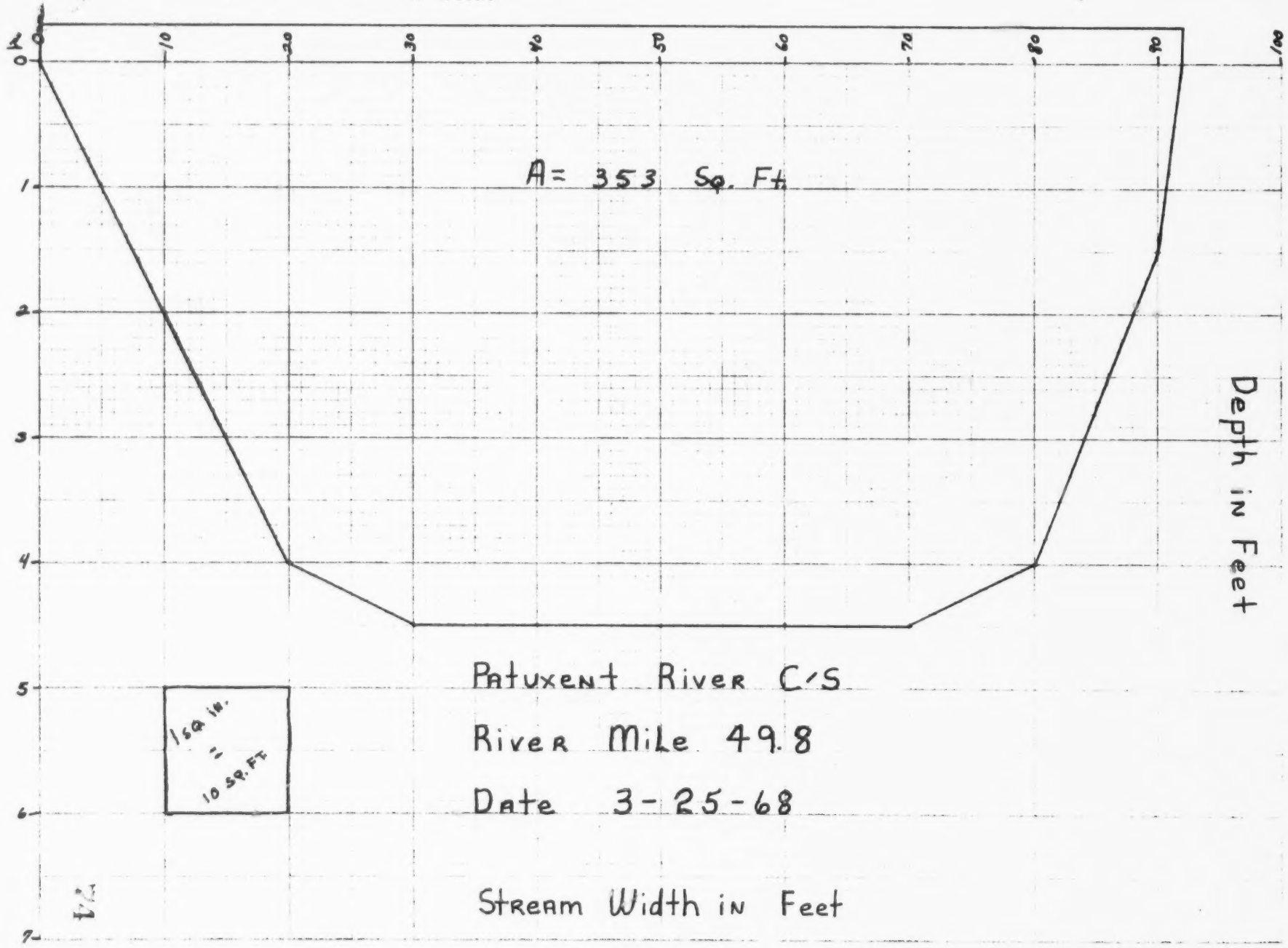


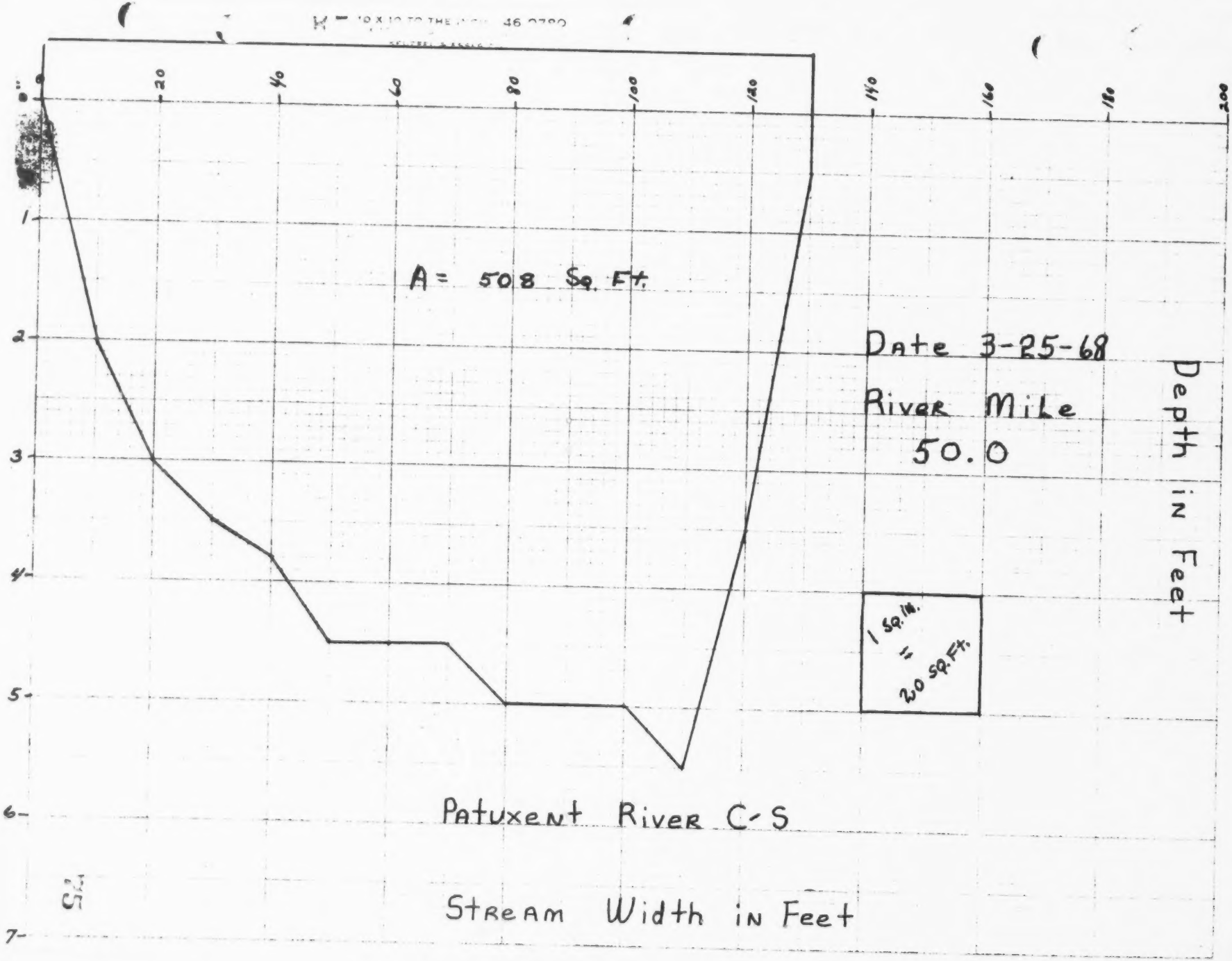
Patuxent River C/S

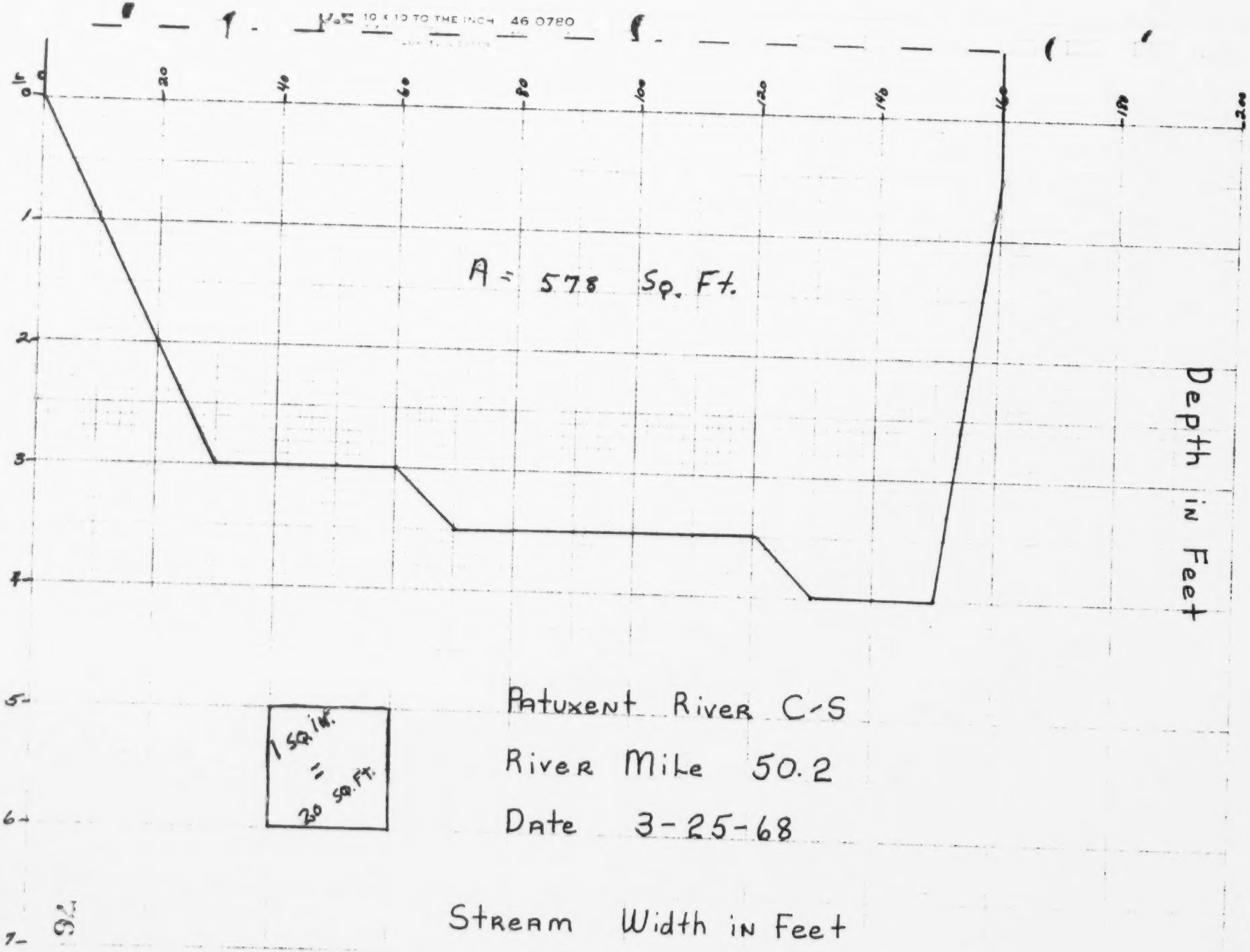
River Mile 49.4

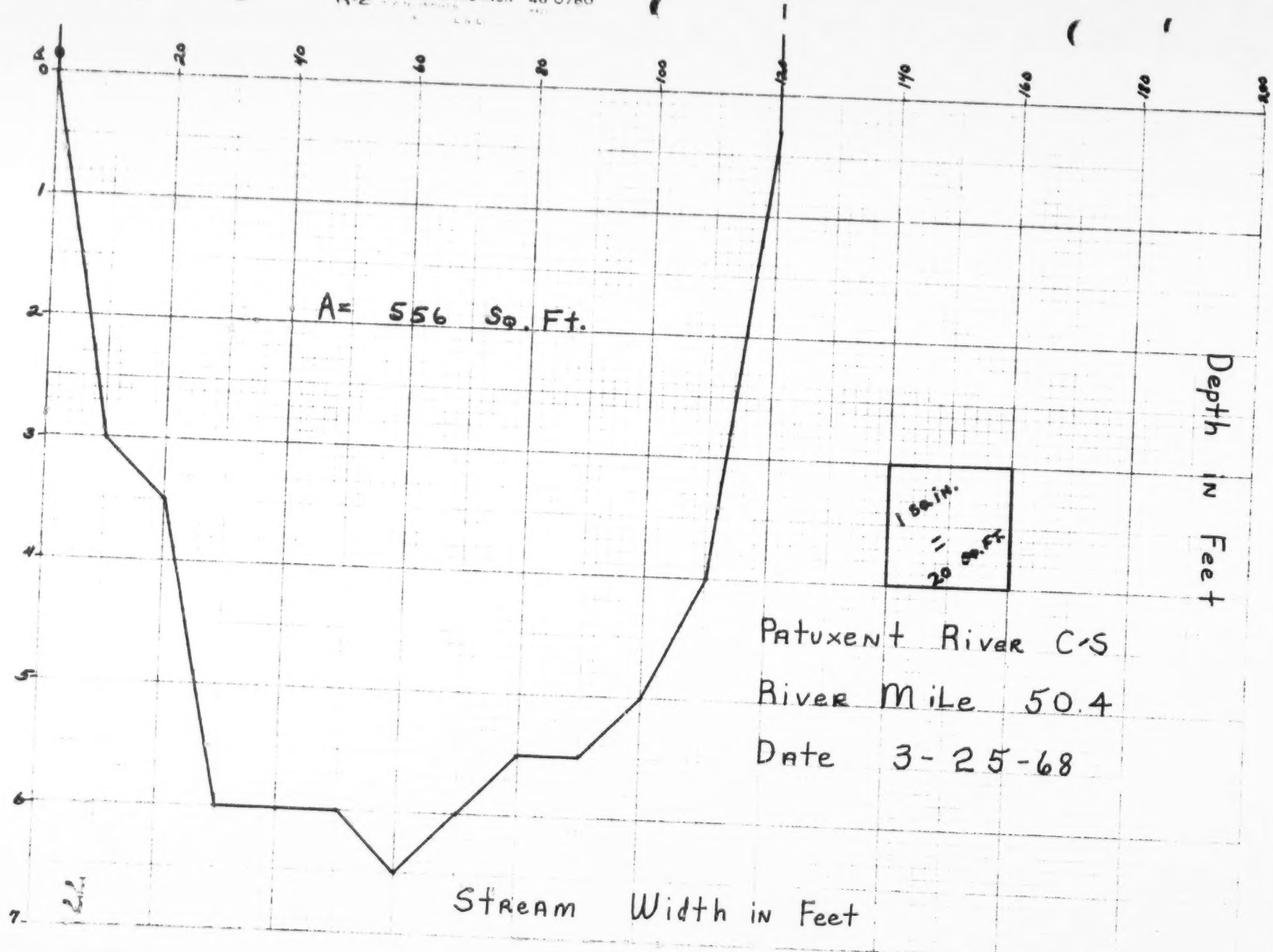
Date 3-25-68

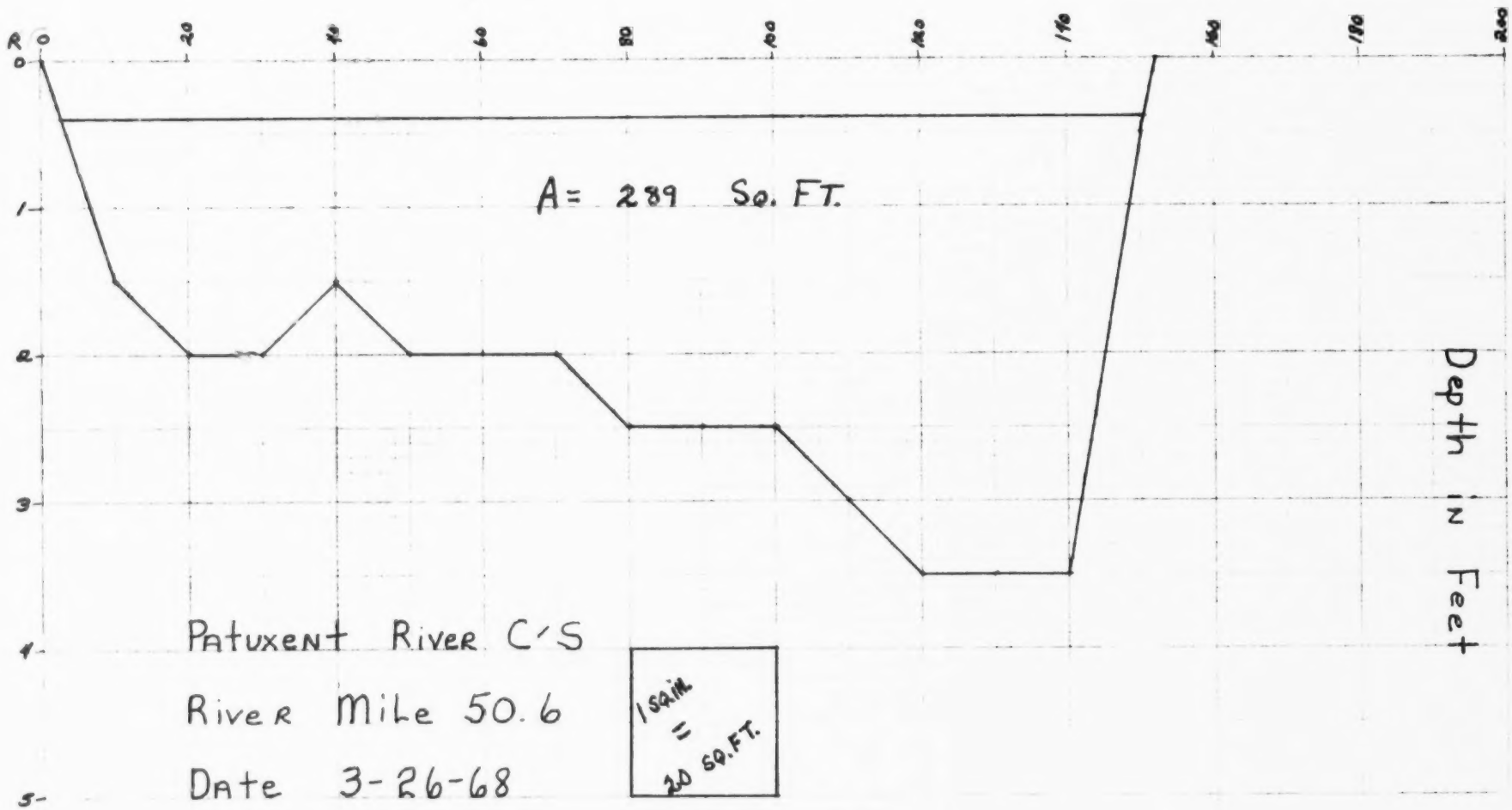

A = 391 Sq. Ft.
Depth in Feet
Patuxent River C/S
River Mile 49.6
Date 3-25-68
1 sq. in. = 20 sq. ft.
Stream Width in Feet

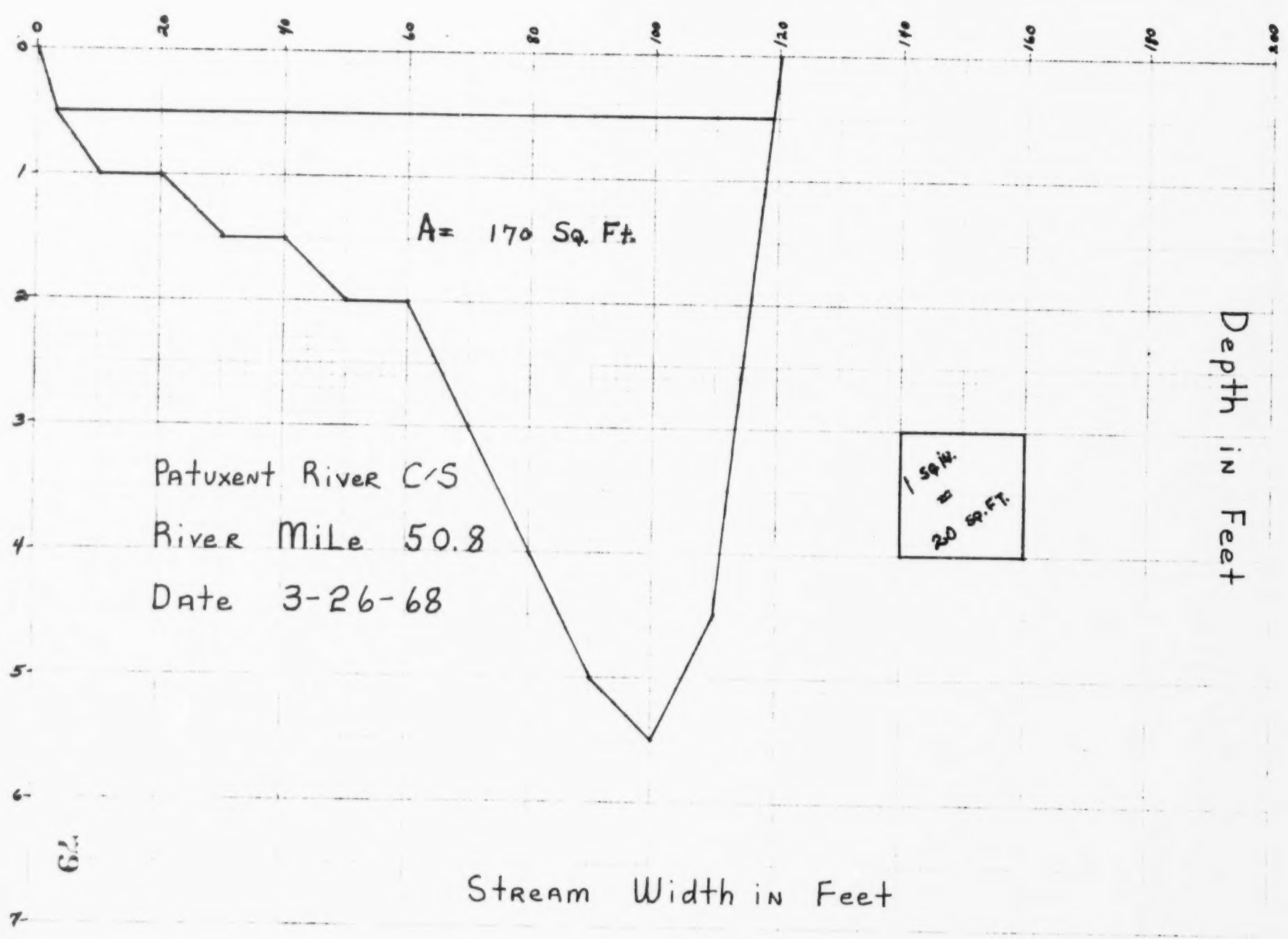

10 X 10 TO THE INCH 46 0780
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
5
6
7
A= 353 Sq. Ft.
Depth in Feet
1 Sq in. = 10 Sq. Ft
Patuxent River C/S
River Mile 49.8
Date 3-25-68
Stream Width in Feet

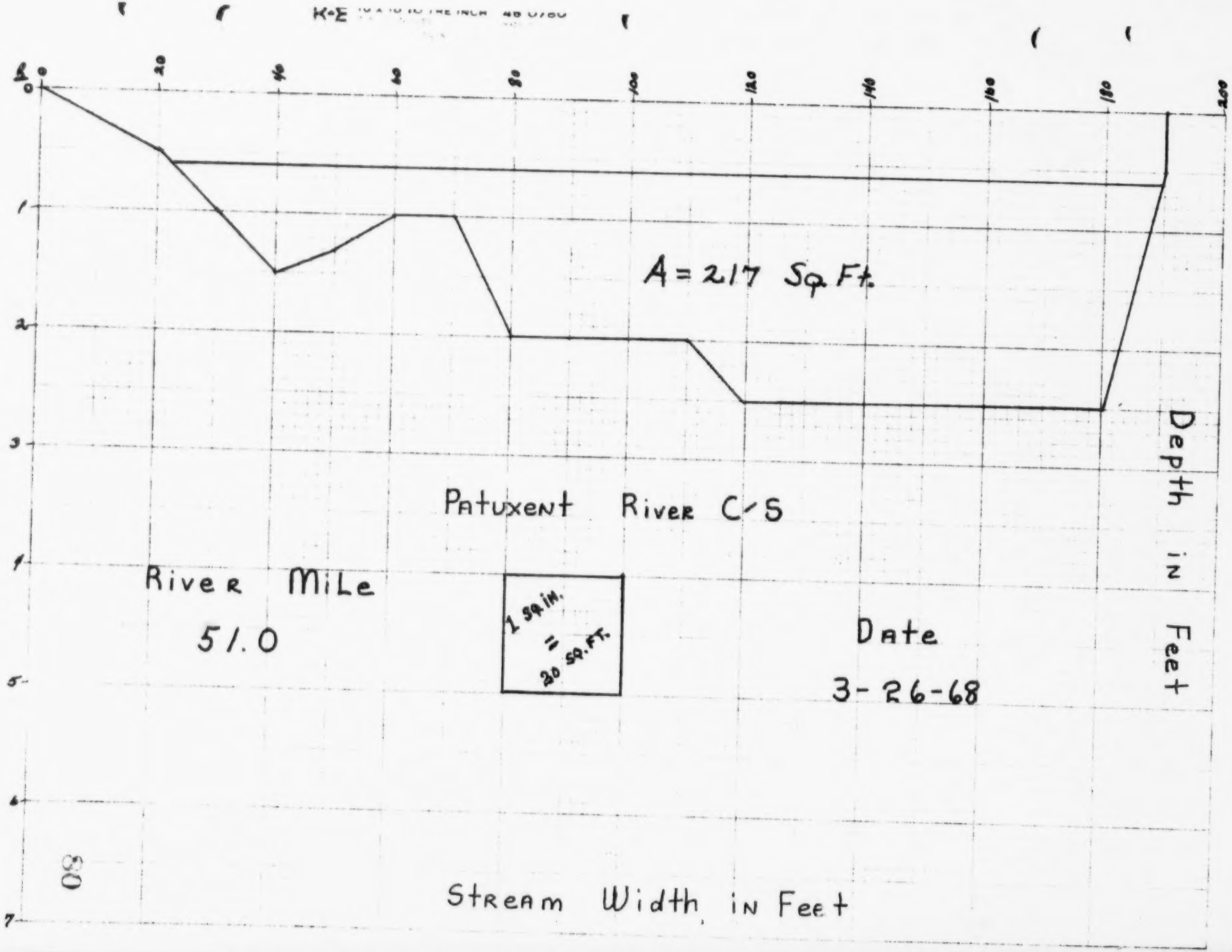

0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
A = 508 Sq. Ft.
Date 3-25-68
River Mile
50.0
1 Sq. In. = 20 Sq. Ft.
Depth in Feet
Patuxent River C-S
Stream Width in Feet

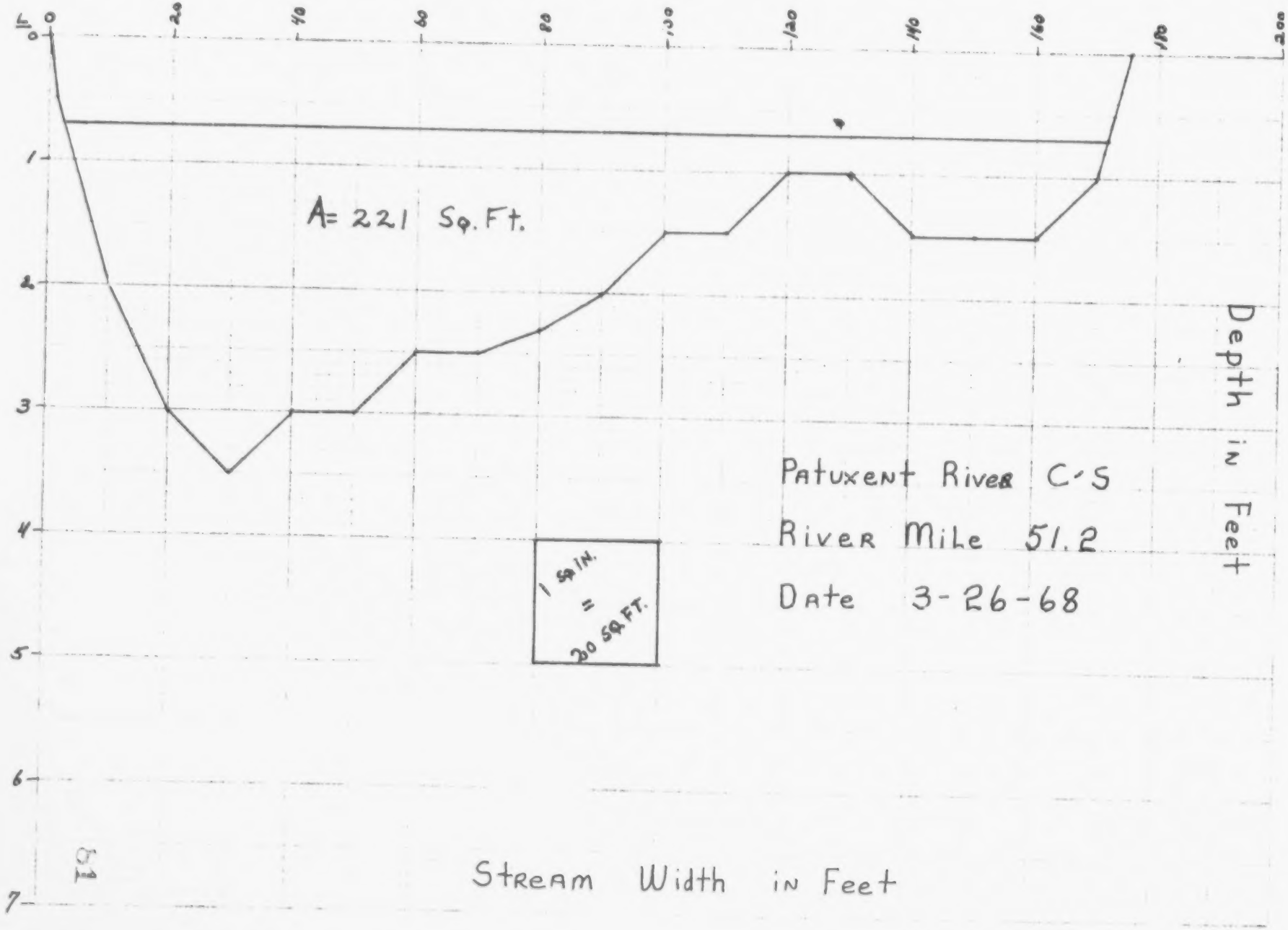

10 X 10 TO THE INCH 46 0780
0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
A = 578 Sq. Ft.
Depth in Feet
1 Sq. In. = 20 Sq. Ft.
Patuxent River C-S
River Mile 50.2
Date 3-25-68
Stream Width in Feet

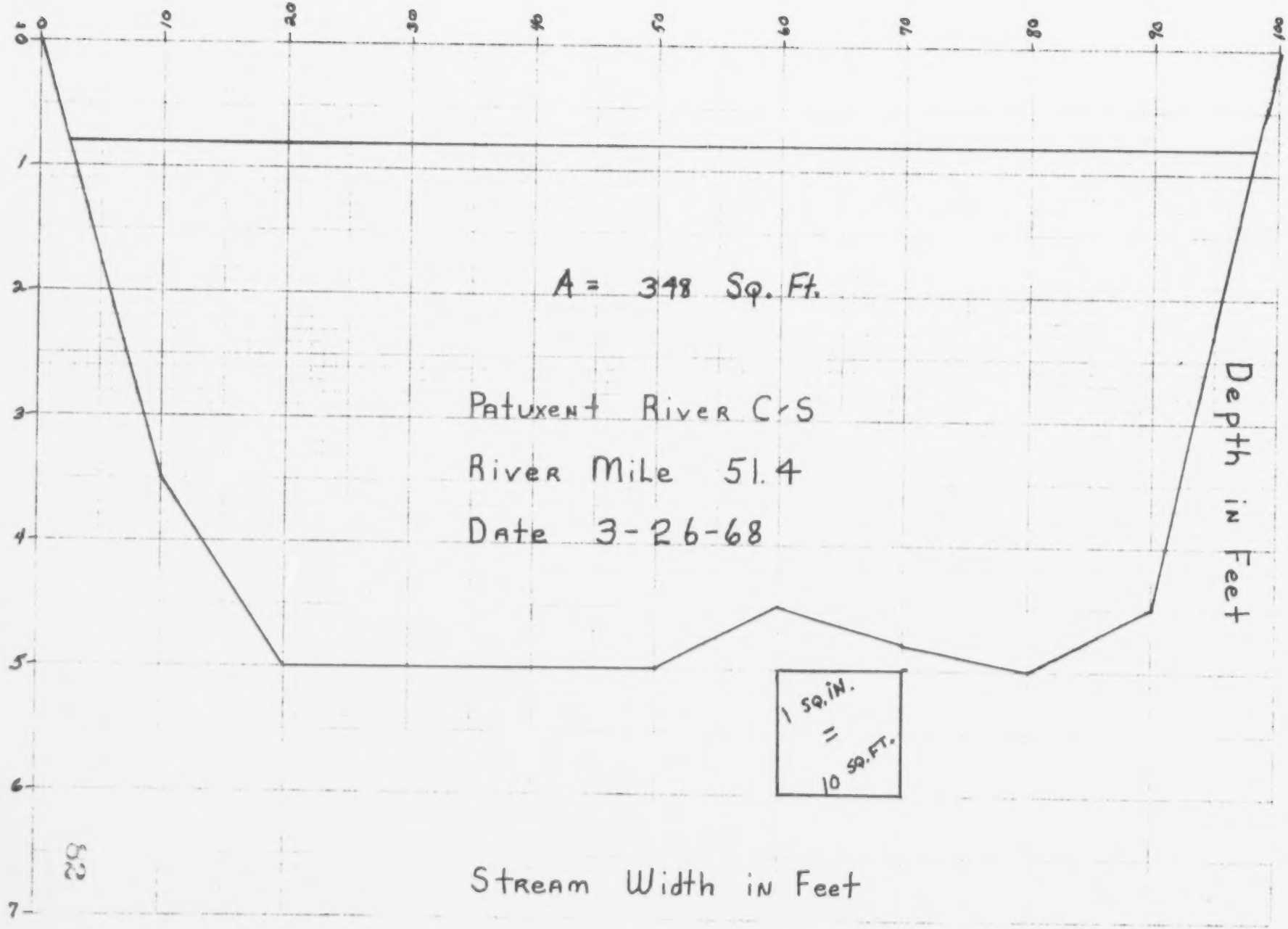

K+E 10 X 10 TO THE INCH 46 0780
0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
A= 556 Sq. Ft.
1 Sq.in. = 20 Sq.Ft.
Depth in Feet
Patuxent River C-S
River Mile 50.4
Date 3-25-68
Stream Width in Feet

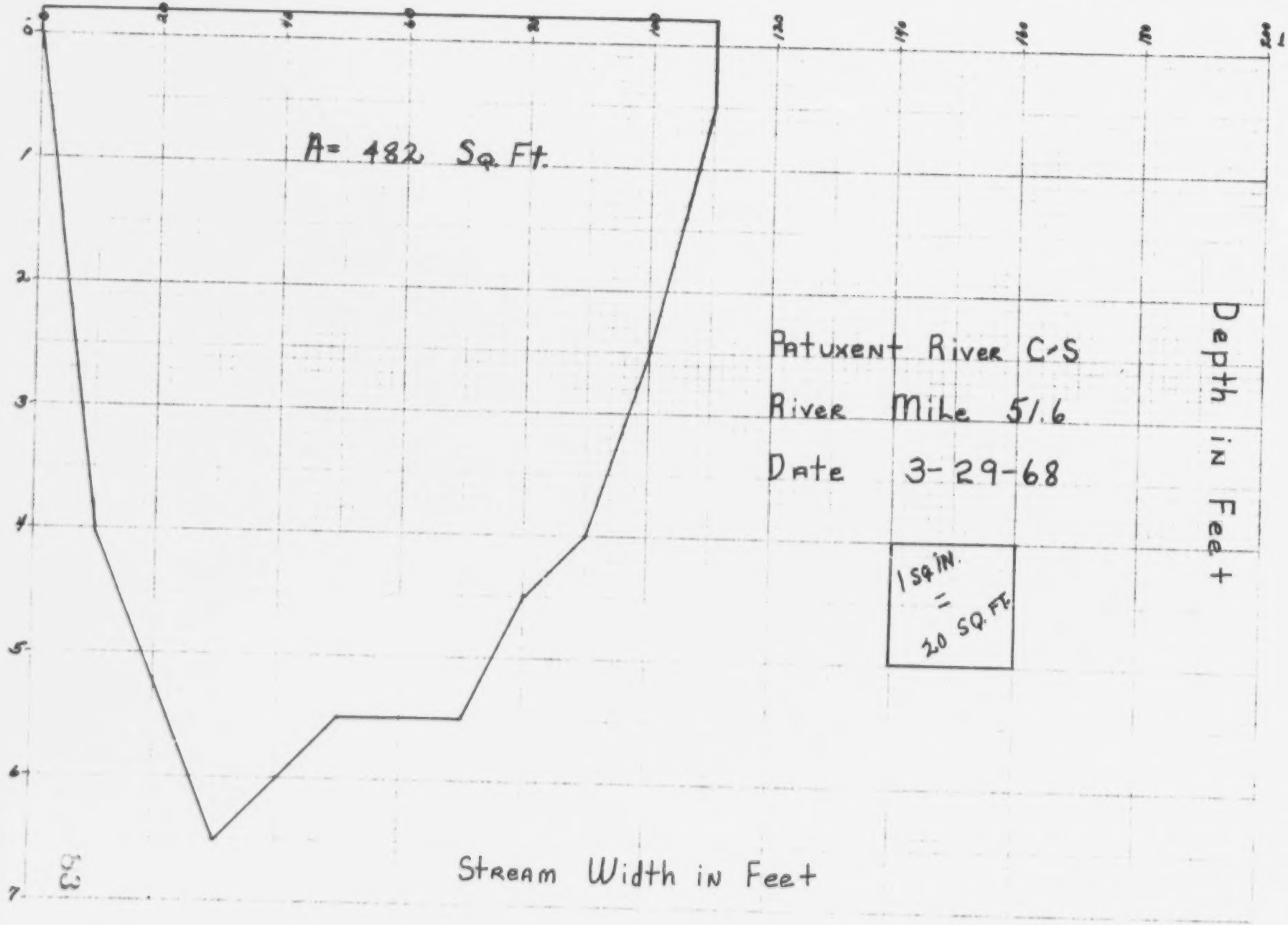

R
0
20
40
60
80
100
120
140
160
180
200
0
1
2
3
4
5
6
7
A= 289 Sq. FT.
Depth in Feet
Patuxent River C'S
River Mile 50.6
Date 3-26-68
1 SQ.IN. = 20 SQ.FT.
Stream Width in Feet

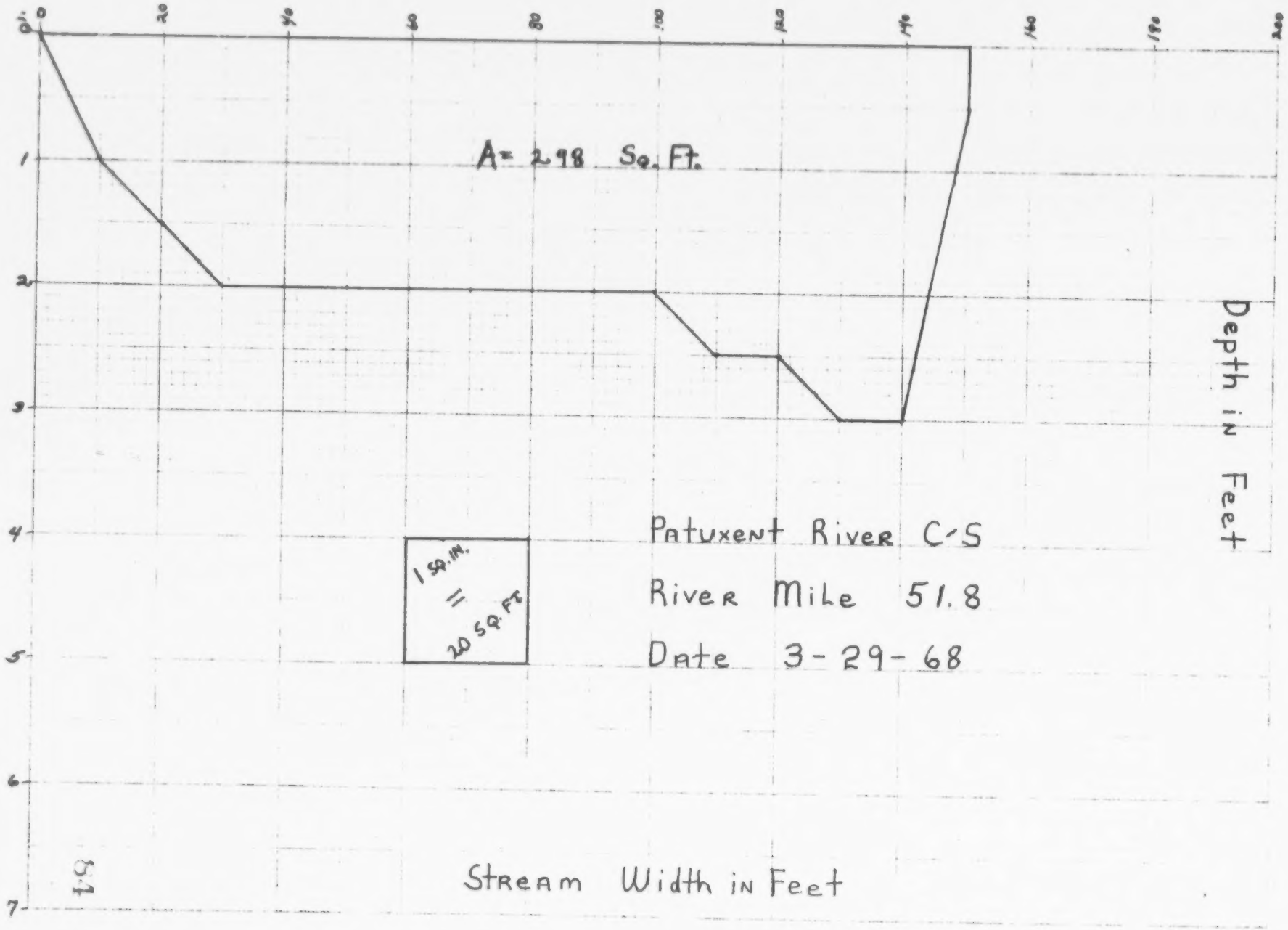

0
20
40
60
80
100
120
140
160
180
200
0
1
2
3
4
5
6
7
A= 170 Sq. Ft.
Patuxent River C/S
River Mile 50.8
Date 3-26-68
1 Sq. In. = 20 Sq. Ft.
Depth in Feet
Stream Width in Feet

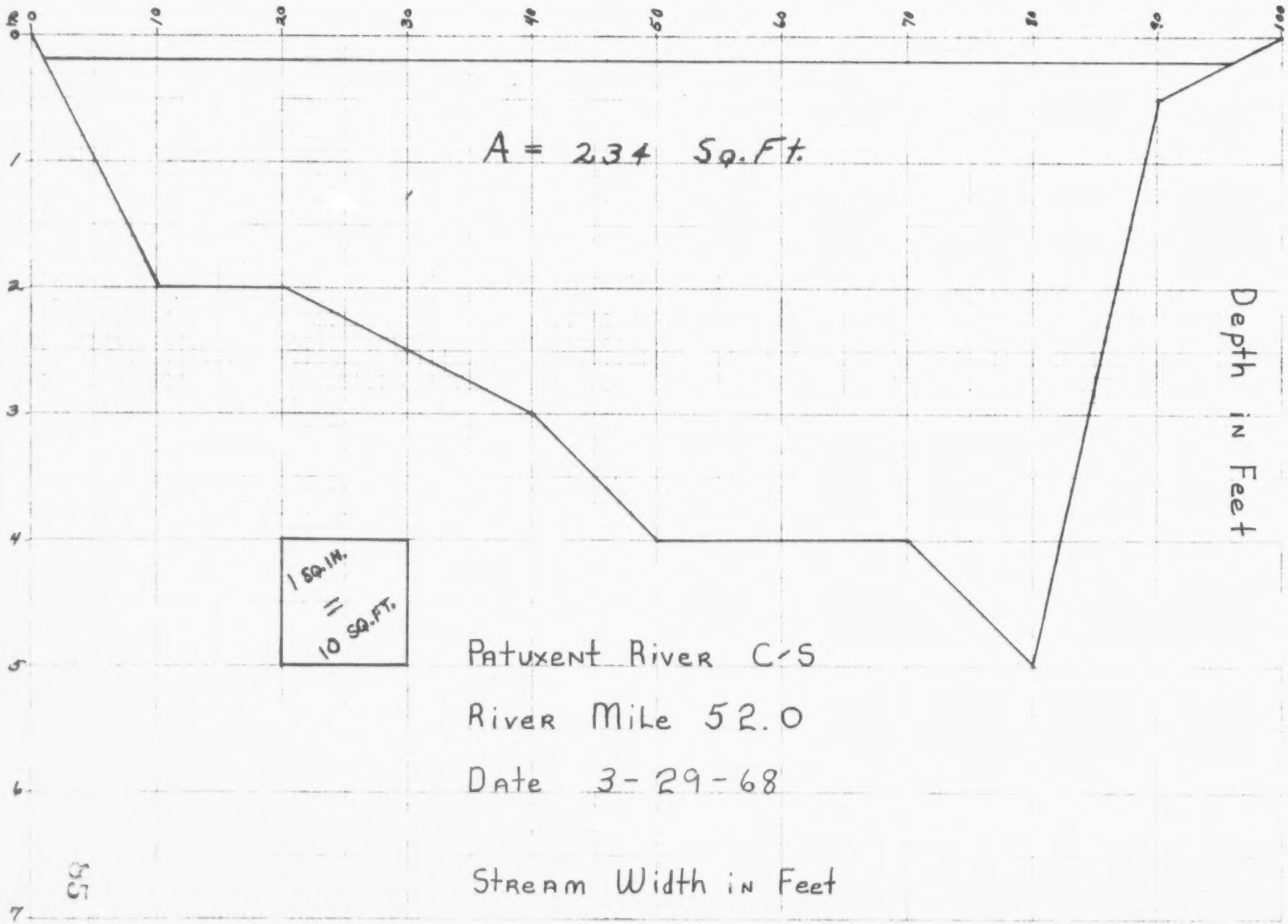

A = 217 Sq. Ft.
Patuxent River C/S
River Mile
51.0
1 SQ. IN. = 20 SQ. FT.
Date
3-26-68
Depth in Feet
Stream Width in Feet

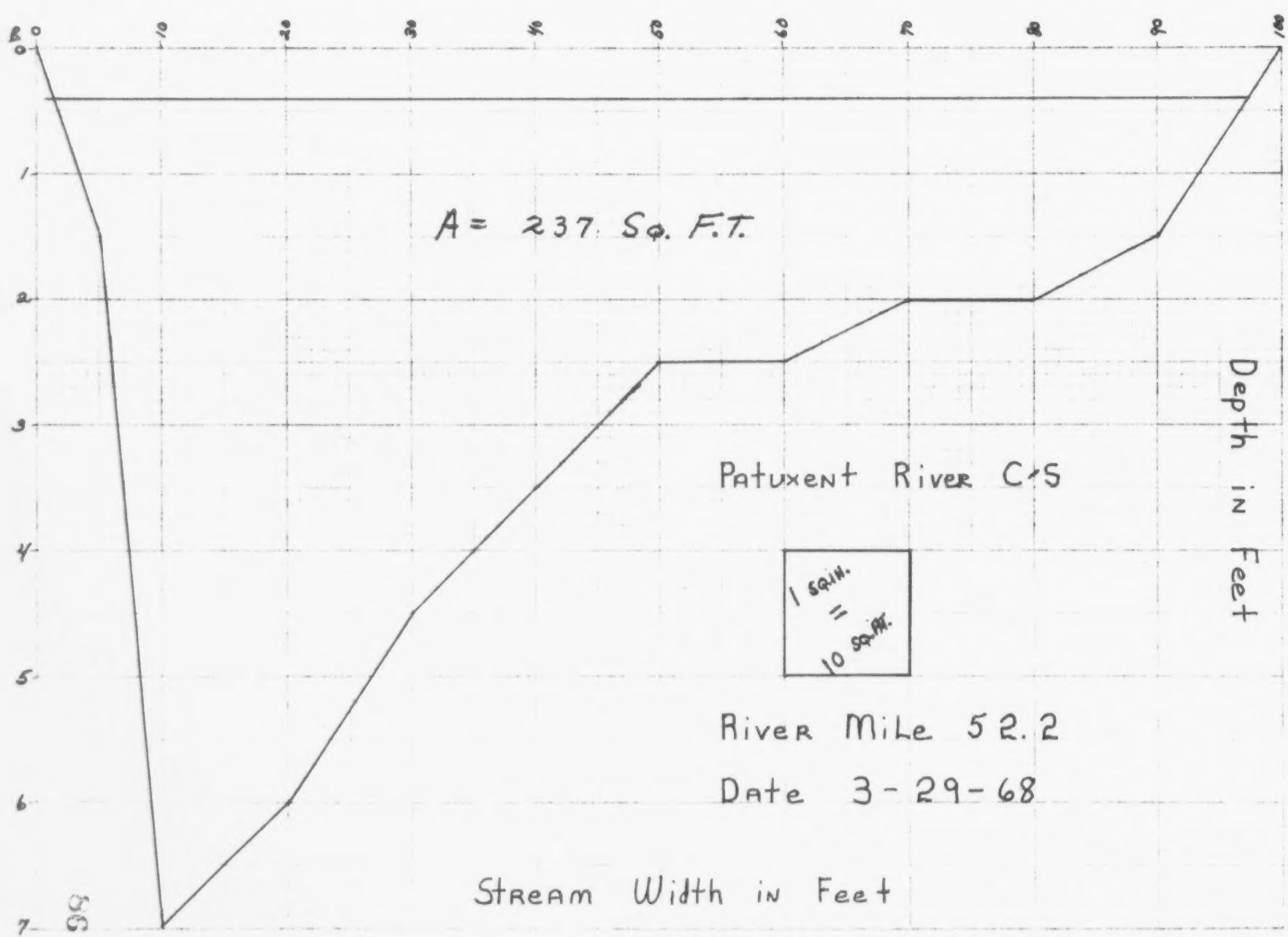

0
20
40
60
80
100
120
140
160
180
200
1
2
3
4
5
6
7
A= 221 Sq. Ft.
1 SQ IN. = 20 SQ FT.
Patuxent River C-5
River Mile 51.2
Date 3-26-68
Depth in Feet
Stream Width in Feet

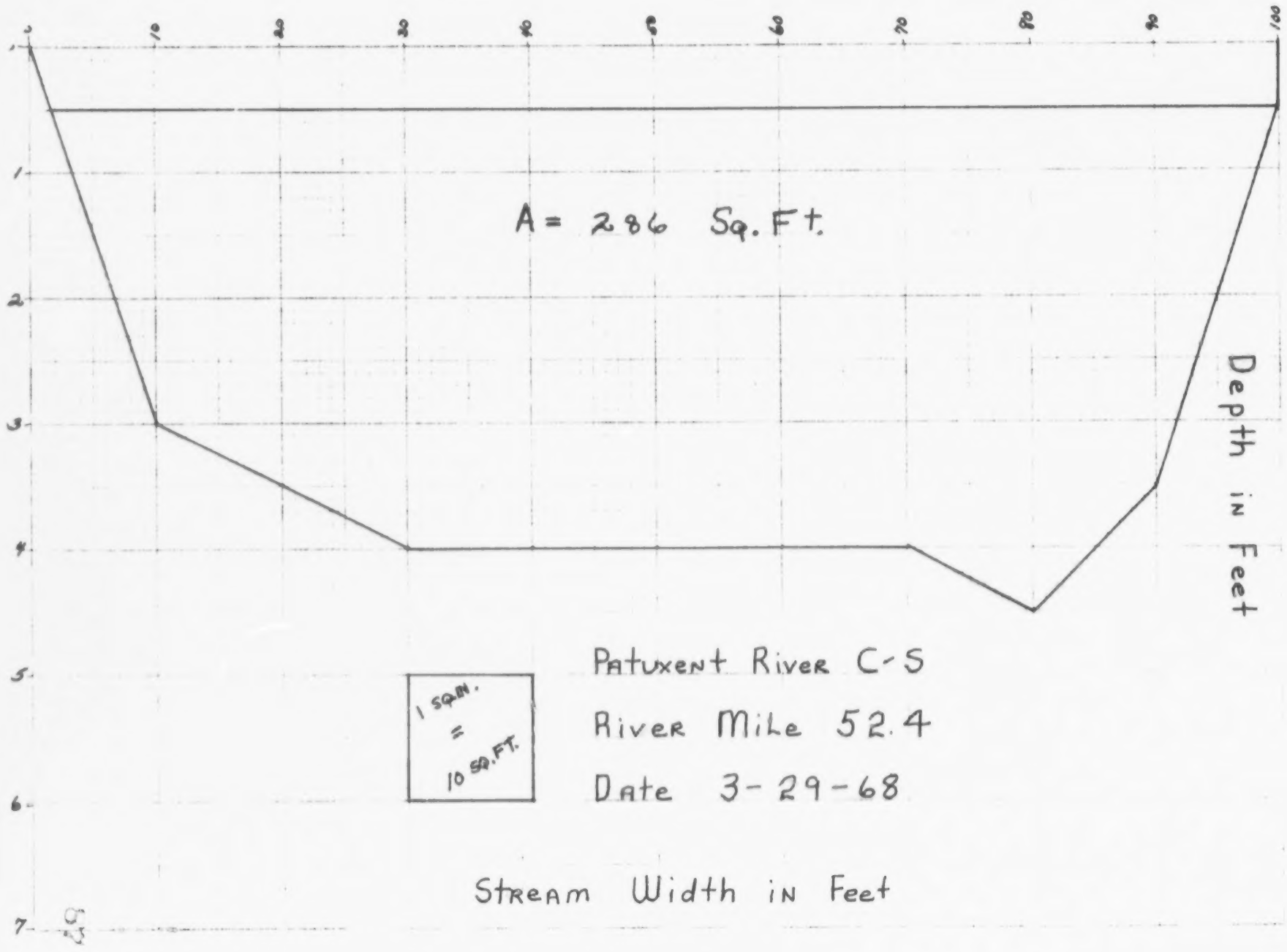

A = 348 Sq. Ft.
Patuxent River C-S
River Mile 51.4
Date 3-26-68
1 SQ. IN. = 10 SQ. FT.
Depth in Feet
Stream Width in Feet

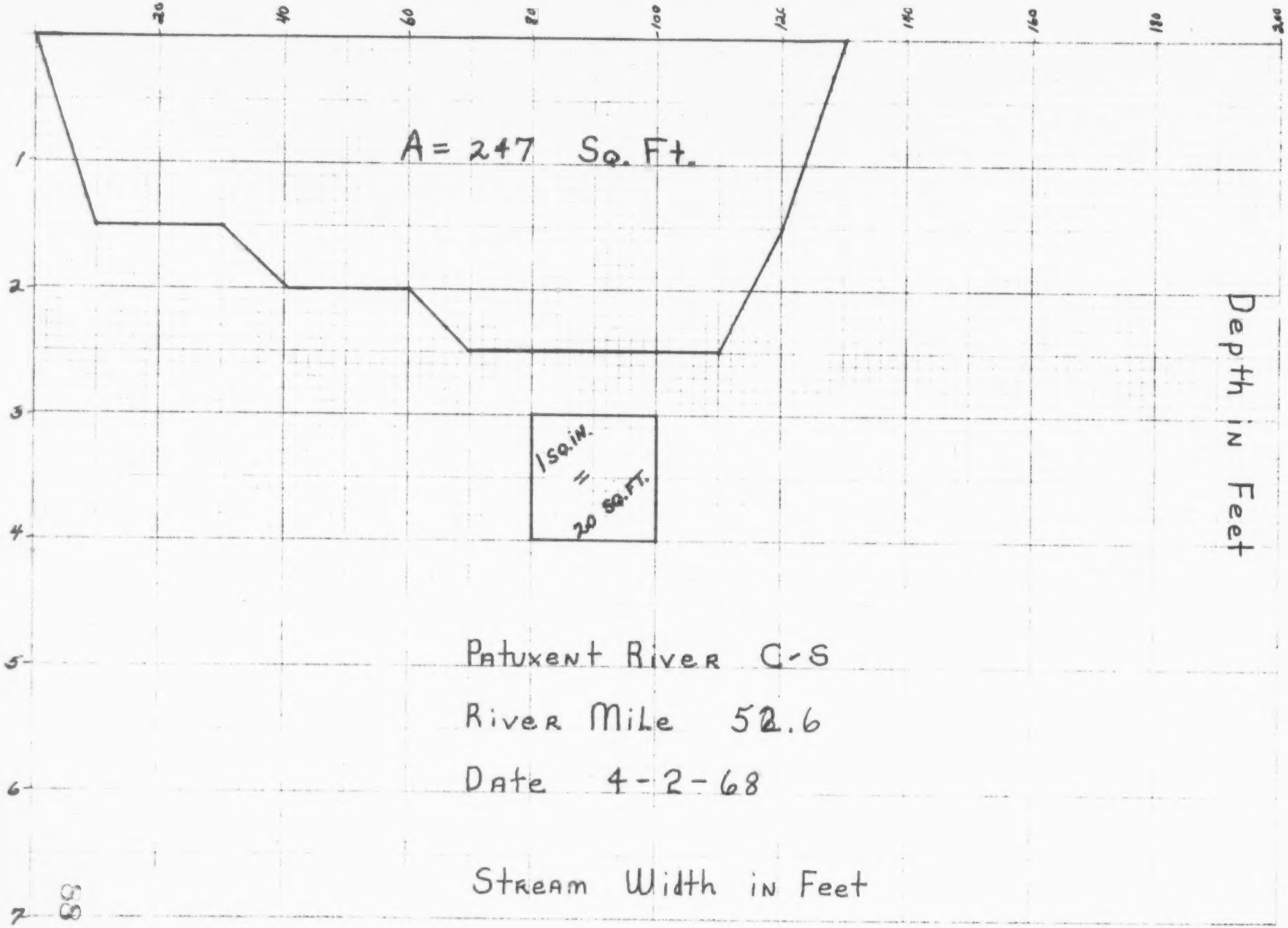

A= 482 Sq. Ft.
Patuxent River C-S
River Mile 51.6
Date 3-29-68
1 SQ IN. = 20 SQ. FT.
Depth in Feet
Stream Width in Feet

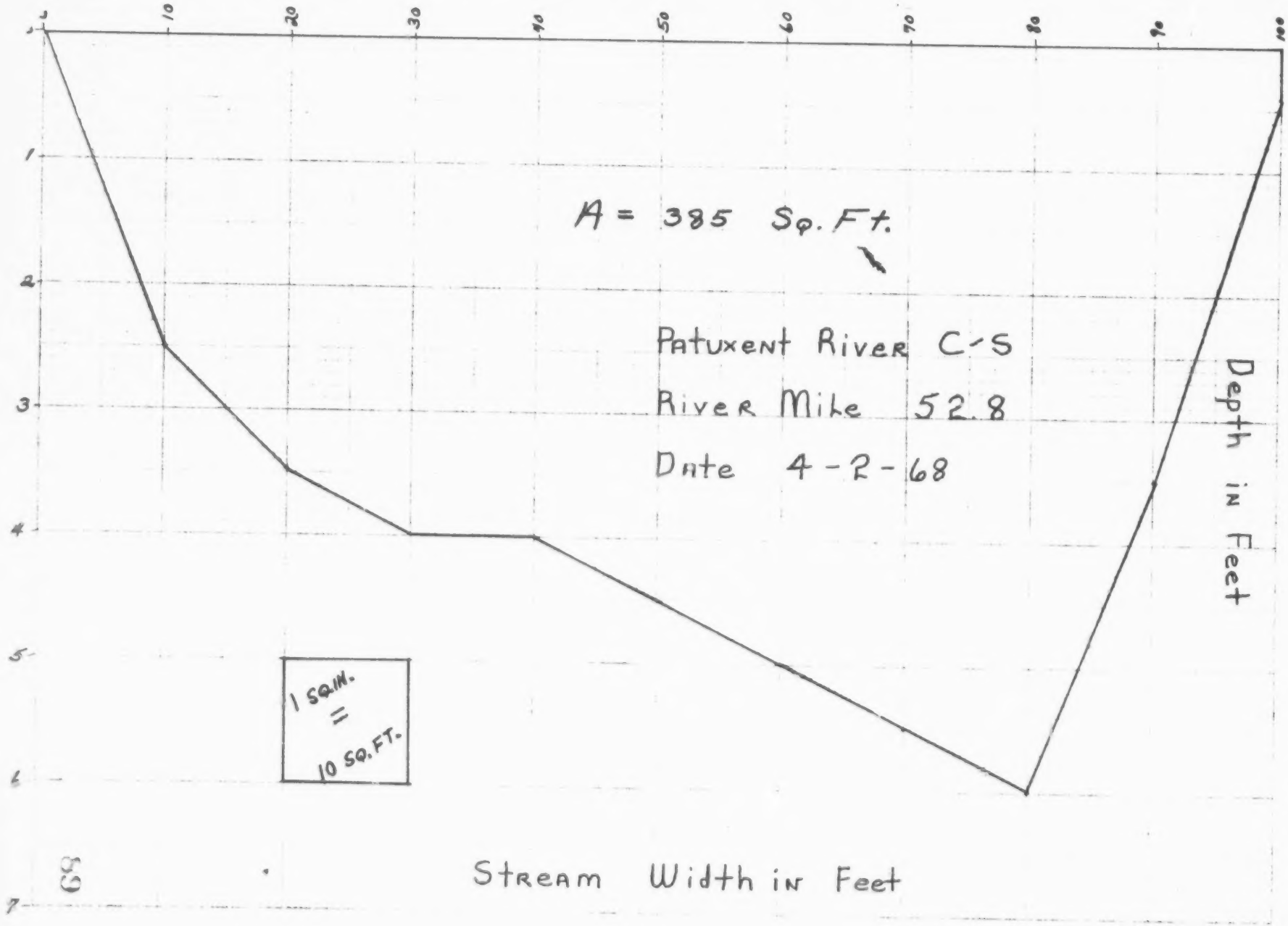

A= 2.98 Sq. Ft.
1 SQ. IN. = 20 SQ. FT
Patuxent River C-S
River Mile 51.8
Date 3-29-68
Depth in Feet
Stream Width in Feet

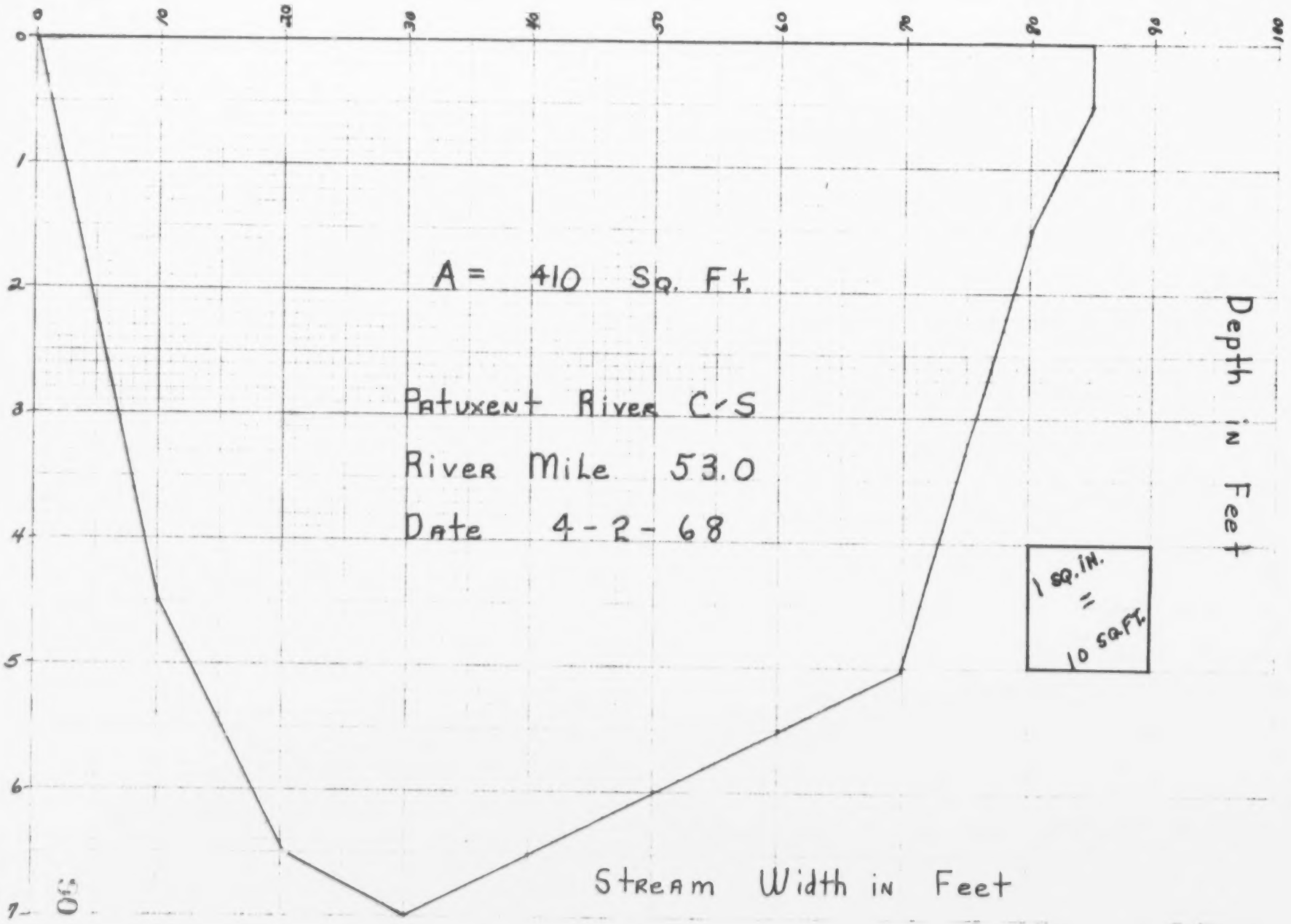

0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
5
6
7
A = 234 Sq. Ft.
1 SQ. IN. = 10 SQ. FT.
Depth in Feet
Patuxent River C-S
River Mile 52.0
Date 3-29-68
Stream Width in Feet

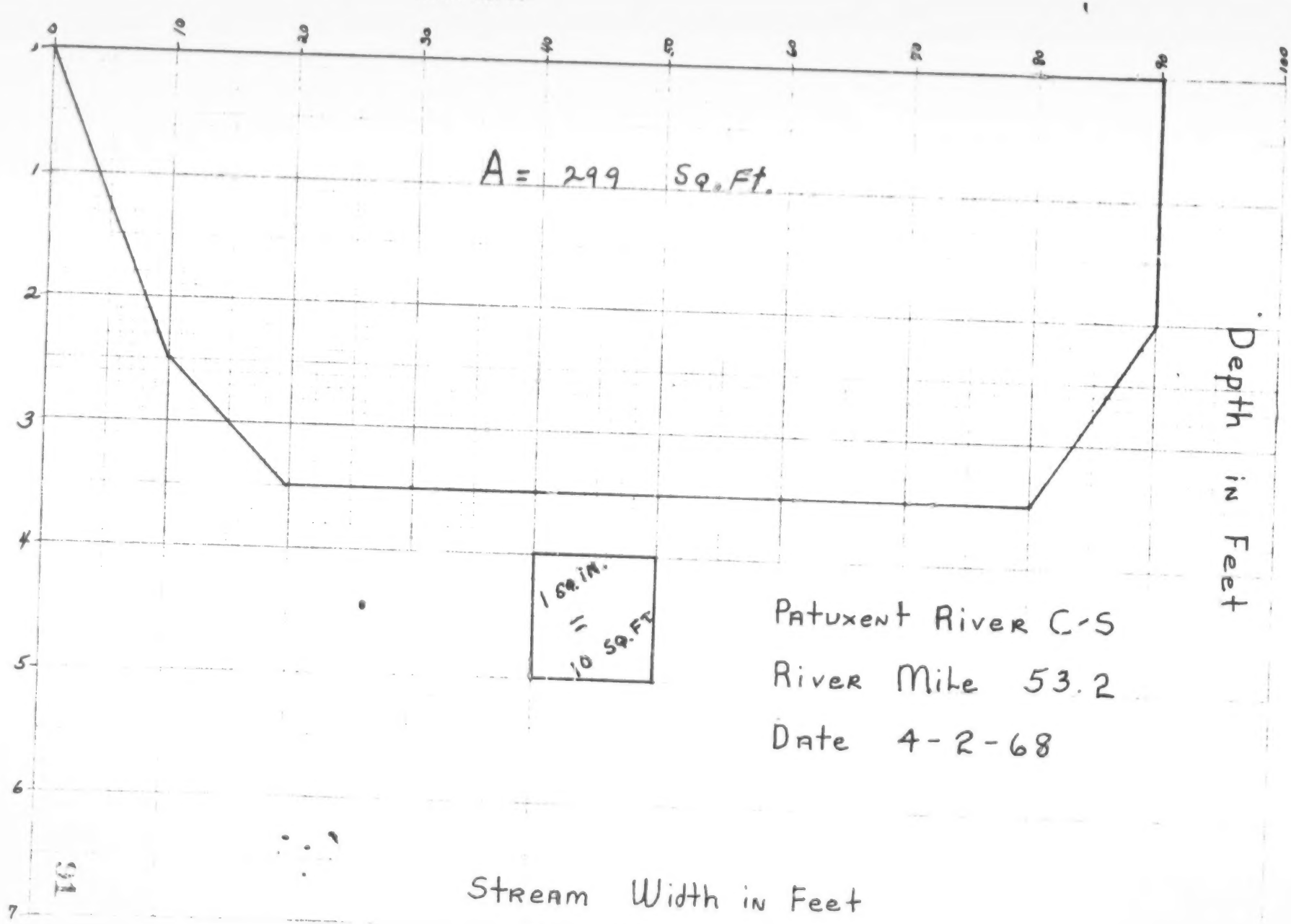

A = 237 Sq. F.T.
Patuxent River C-S
1 SQ.IN. = 10 SQ.FT.
River Mile 52.2
Date 3-29-68
Depth in Feet
Stream Width in Feet


A = 286 Sq. Ft.
Depth in Feet
1 SQR. = 10 SQ. FT.
Patuxent River C-S
River Mile 52.4
Date 3-29-68
Stream Width in Feet


A = 247 Sq. Ft.
1 SQ. IN. = 20 SQ. FT.
Depth in Feet
Patuxent River C-S
River Mile 52.6
Date 4-2-68
Stream Width in Feet


A = 385 Sq. Ft.
Patuxent River C-S
River Mile 52.8
Date 4-2-68
1 SQ.IN. = 10 SQ. FT.
Depth in Feet
Stream Width in Feet

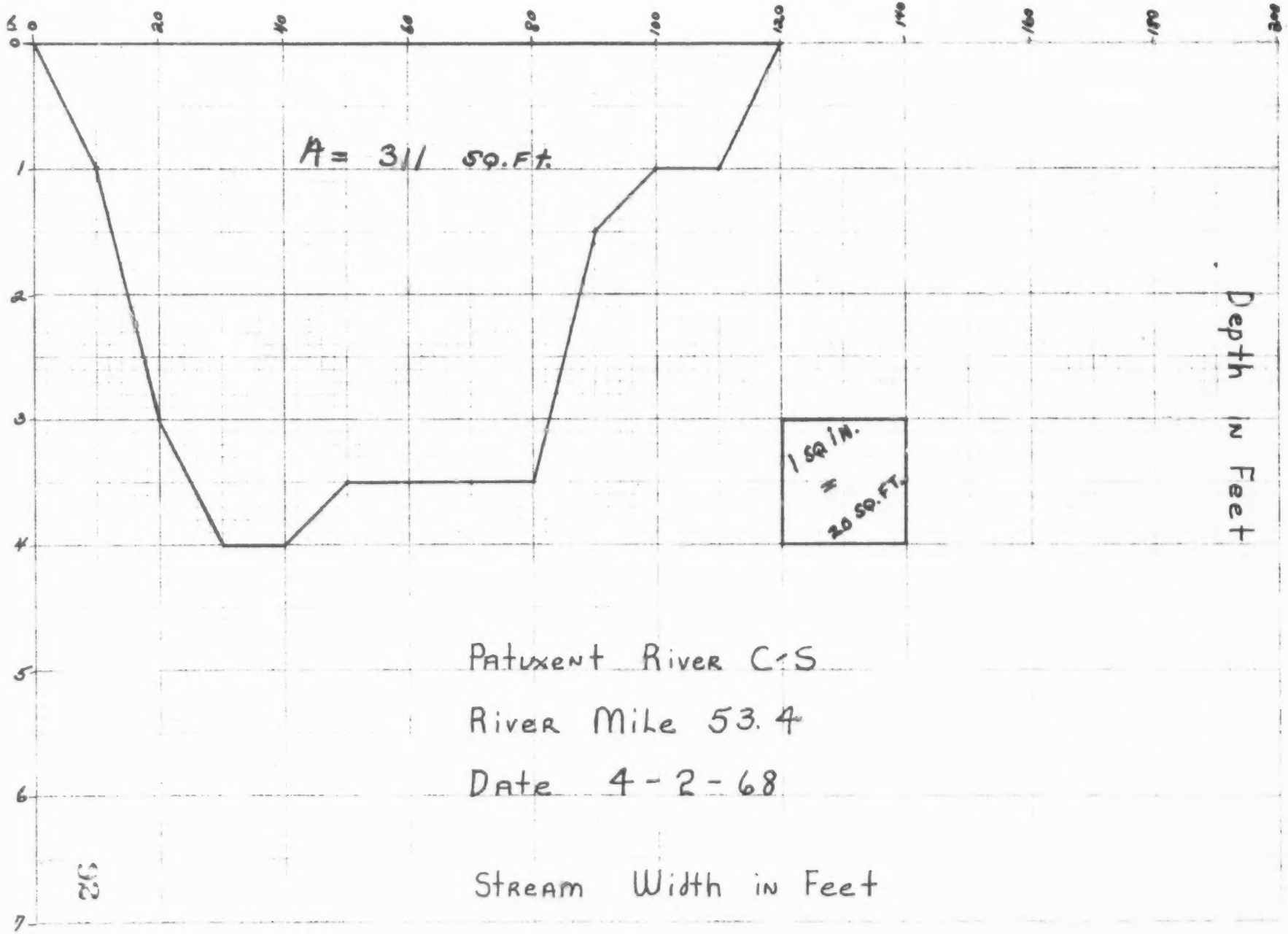

A = 410 Sq. Ft.
Patuxent River C-S
River Mile 53.0
Date 4-2-68
1 SQ. IN. = 10 SQ. FT.
Depth in Feet
Stream Width in Feet



Patuxent River C-S

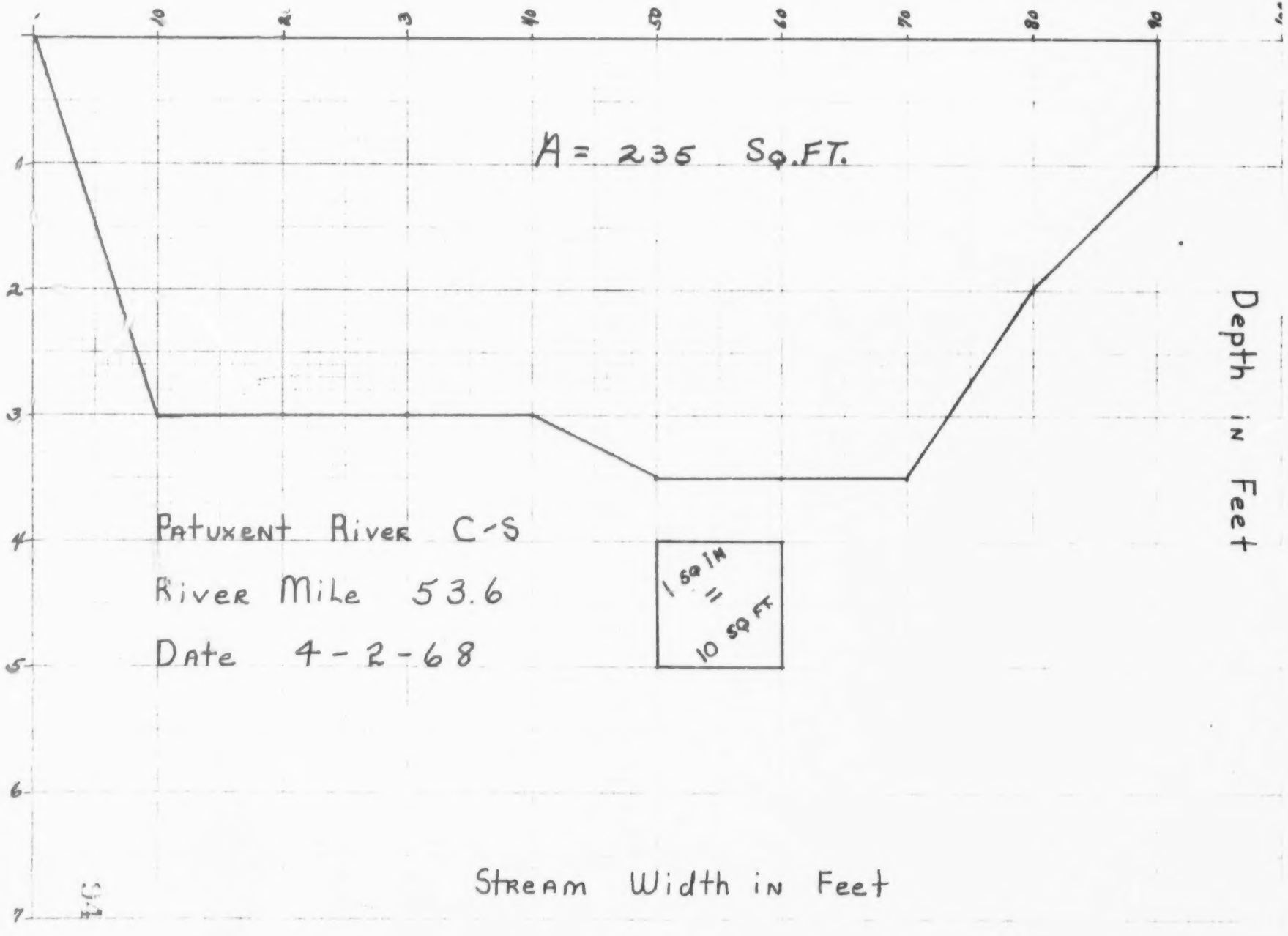
River Mile 53.2

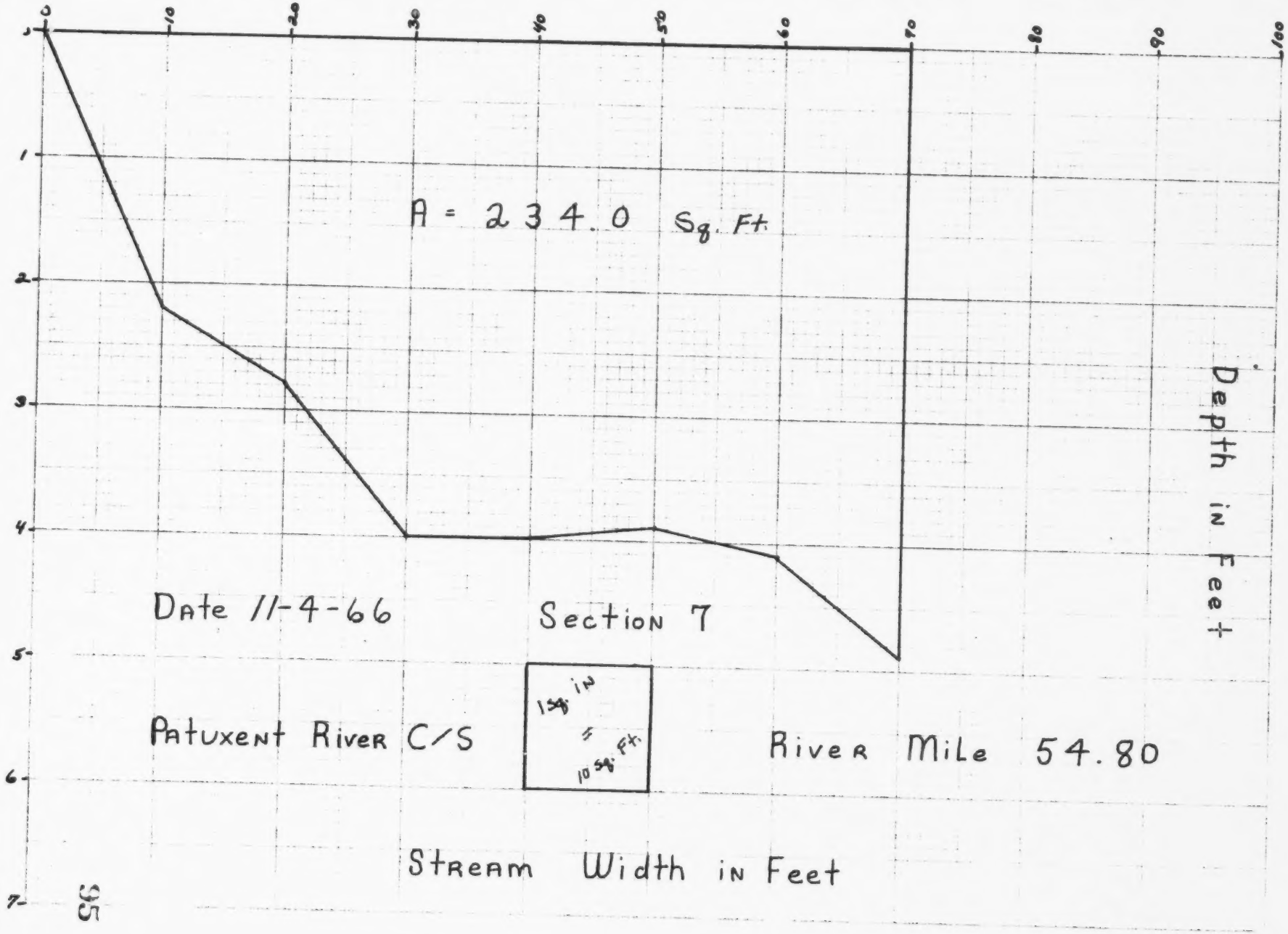
Date 4-2-68

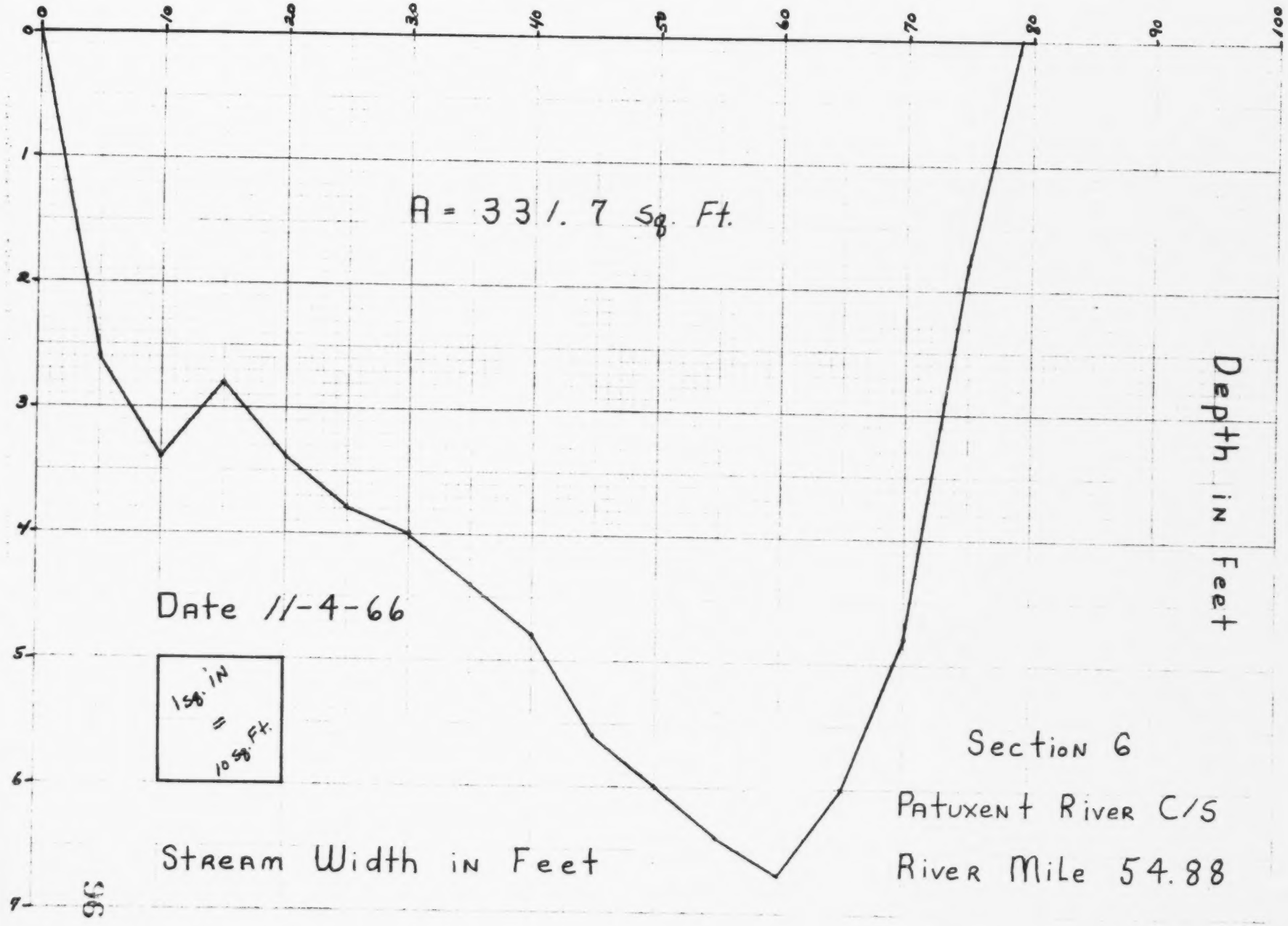

A= 311 SQ.Ft.
1 SQ IN. = 20 SQ. FT.
Depth in Feet
Patuxent River C-S
River Mile 53.4
Date 4-2-68
Stream Width in Feet

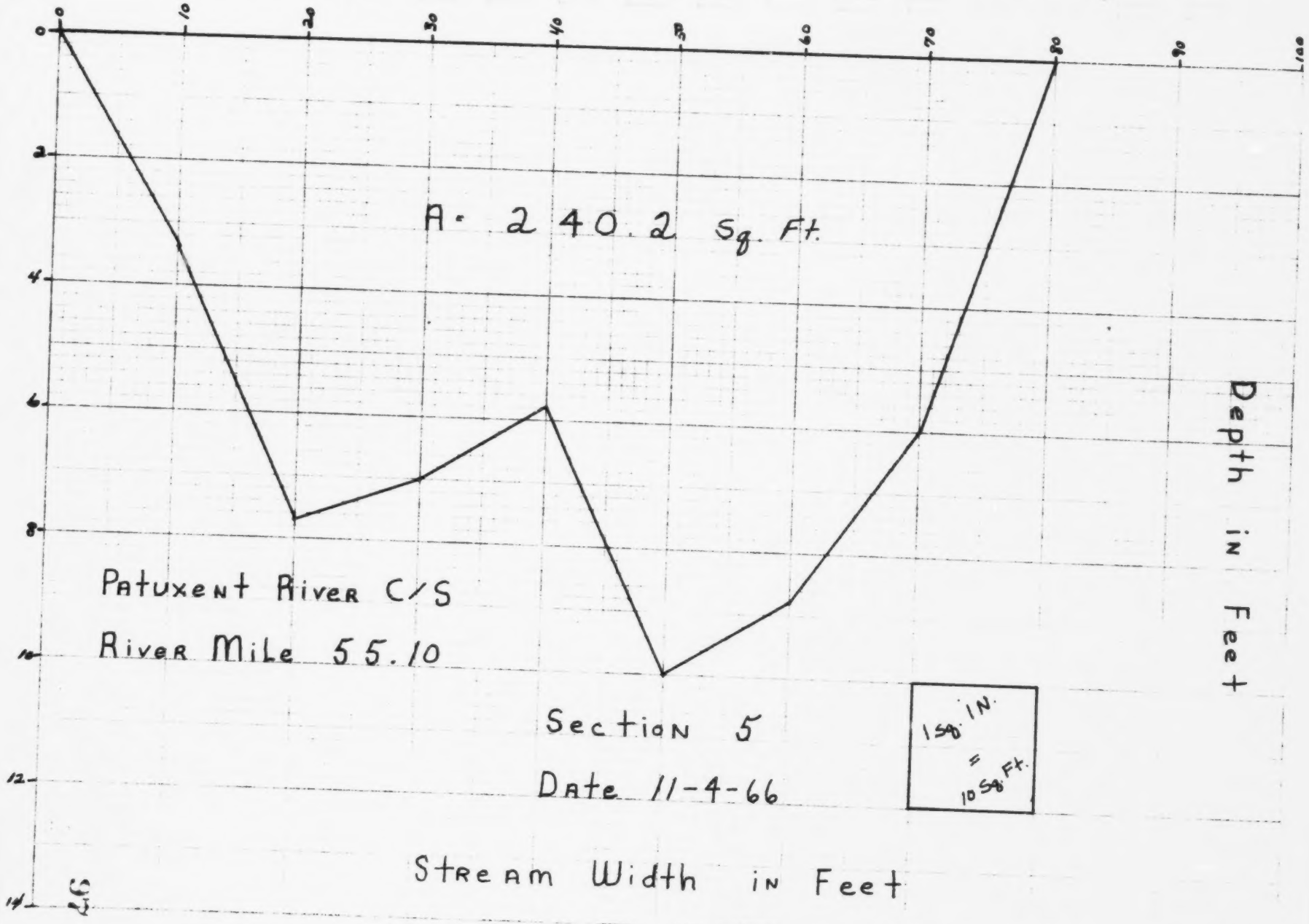
III - D. CROSS-SECTIONS, NON-STEADY STATE

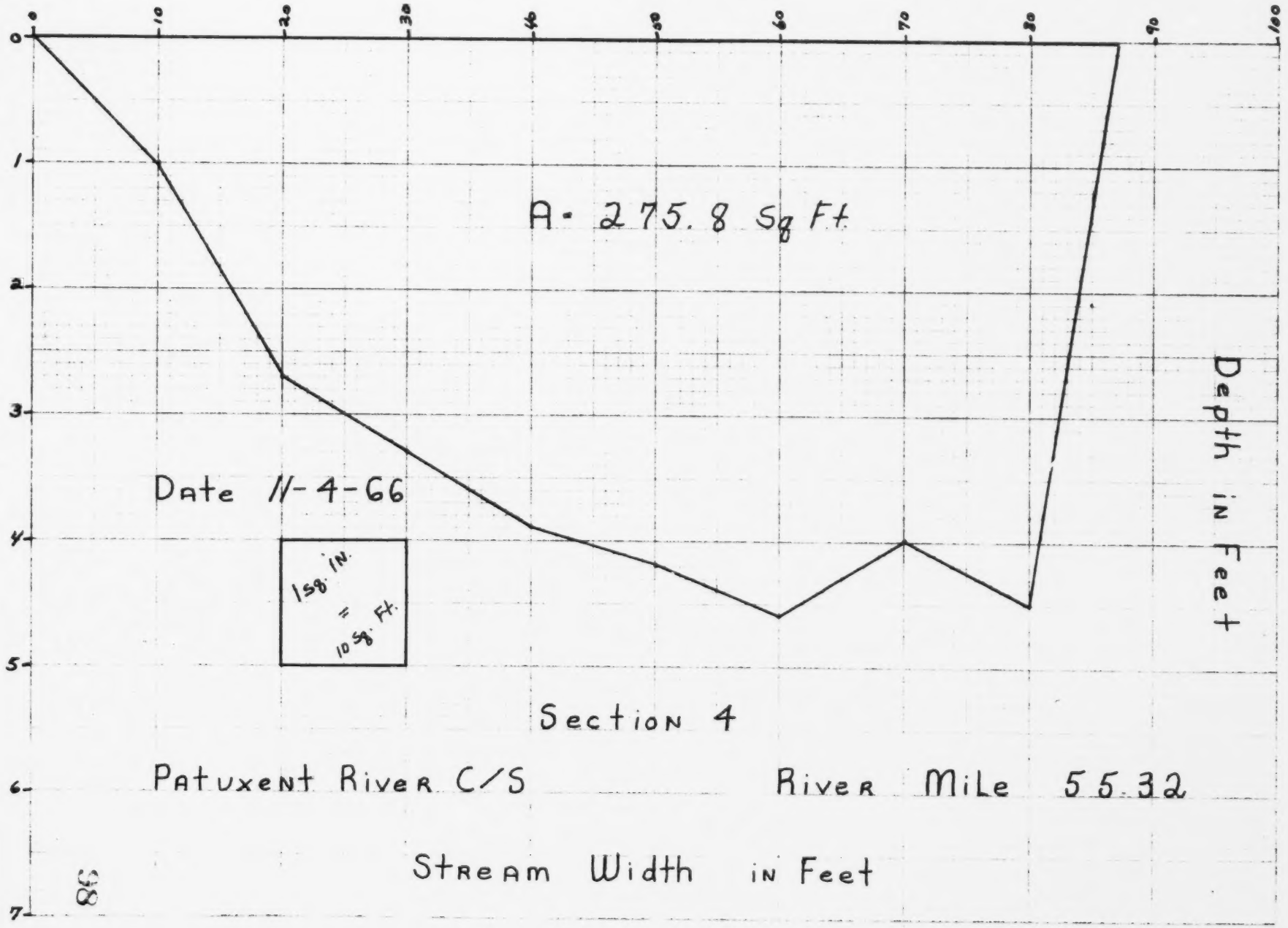
(RIVER MILES 53.6 TO 73.4)

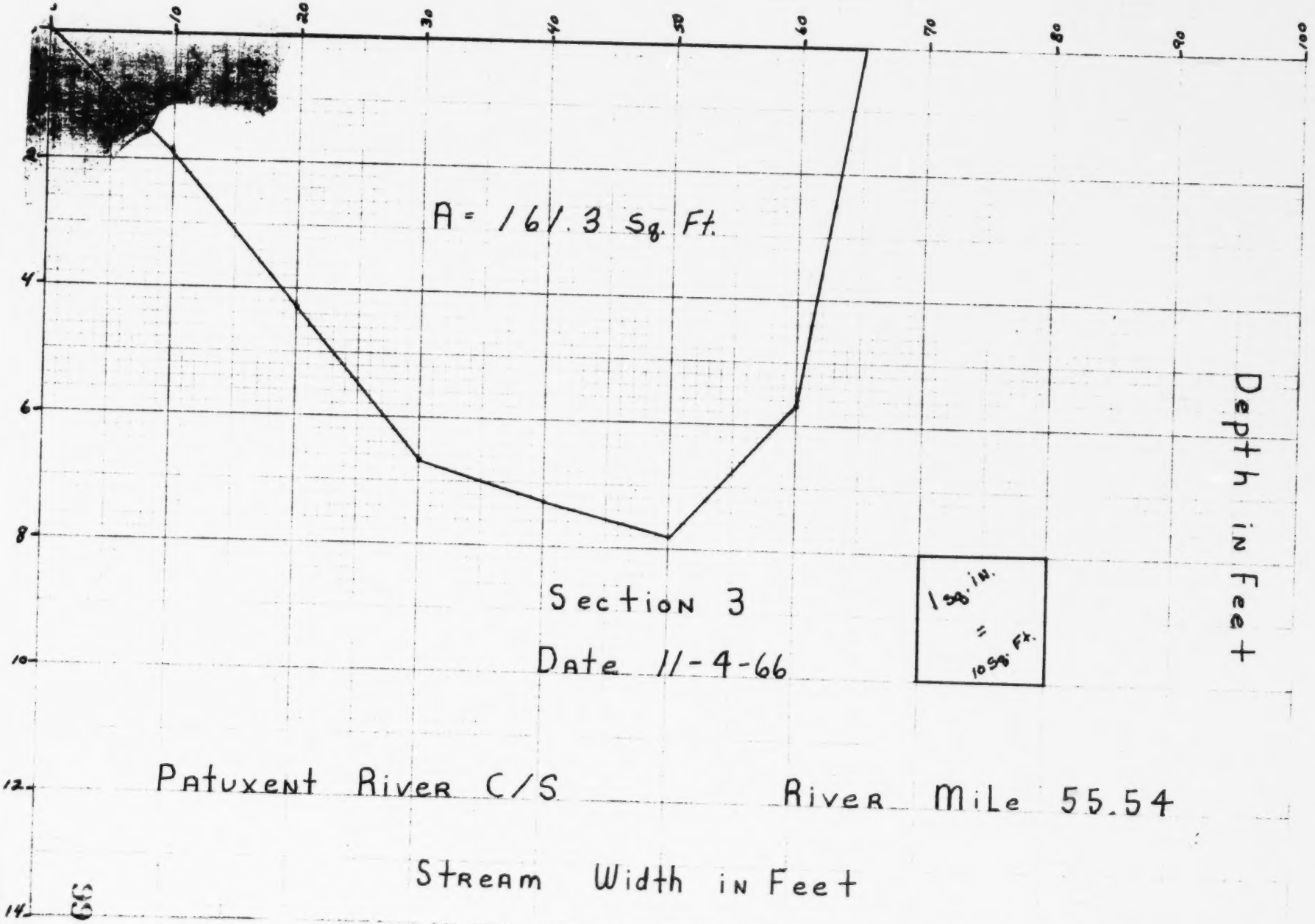

A = 235 Sq.FT.
Depth in Feet
Stream Width in Feet
Patuxent River C-S
River Mile 53.6
Date 4-2-68
1 SQ IN = 10 SQ FT.

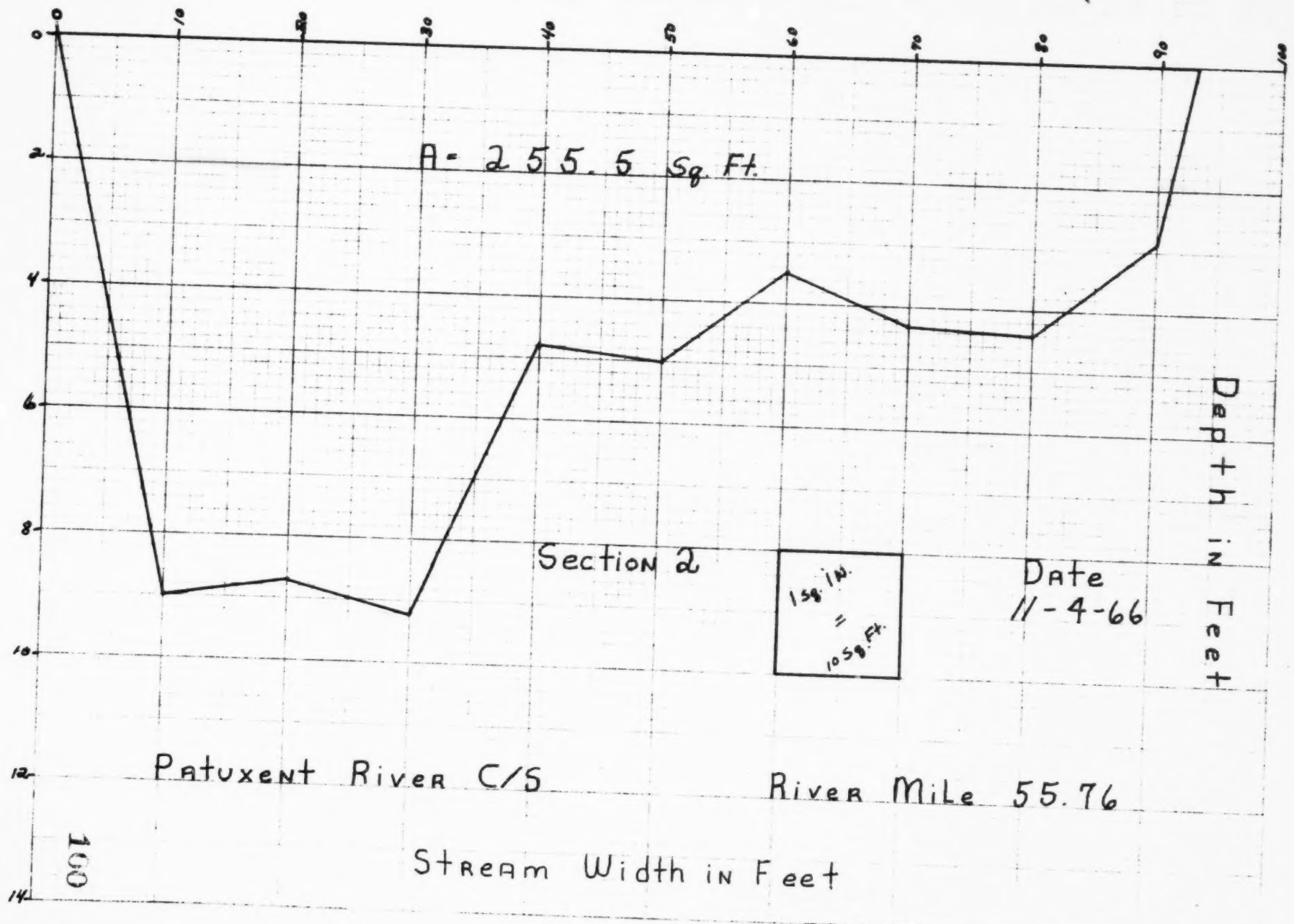

0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
A = 234.0 Sq. Ft.
Depth in Feet
Date 11-4-66
Section 7
Patuxent River C/S
1 Sq. in = 10 Sq. Ft.
River Mile 54.80
Stream Width in Feet

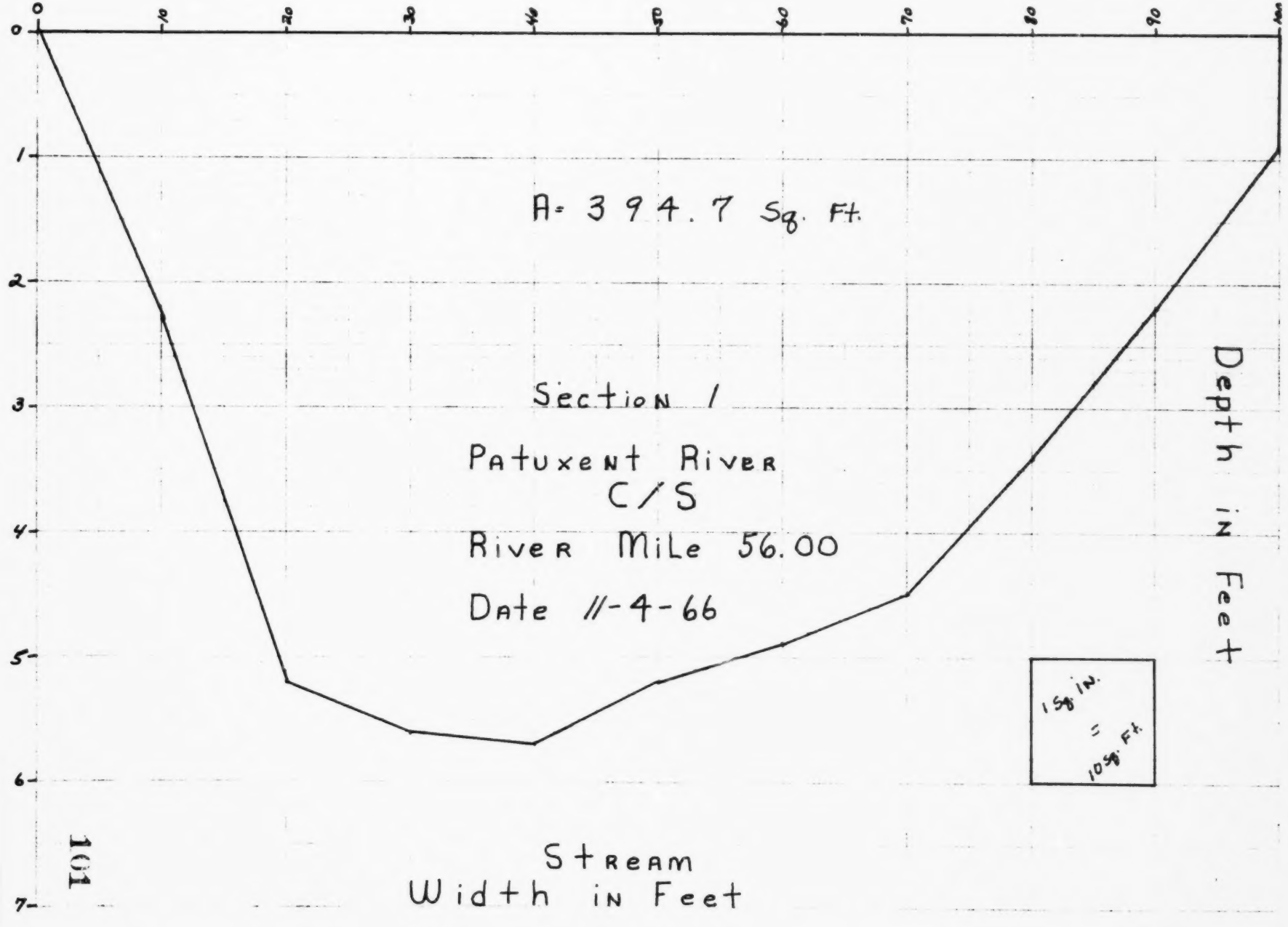

0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
A = 331.7 Sq. Ft.
Depth in Feet
Date 11-4-66
1 Sq. In = 10 Sq. Ft.
Stream Width in Feet
Section 6
Patuxent River C/S
River Mile 54.88

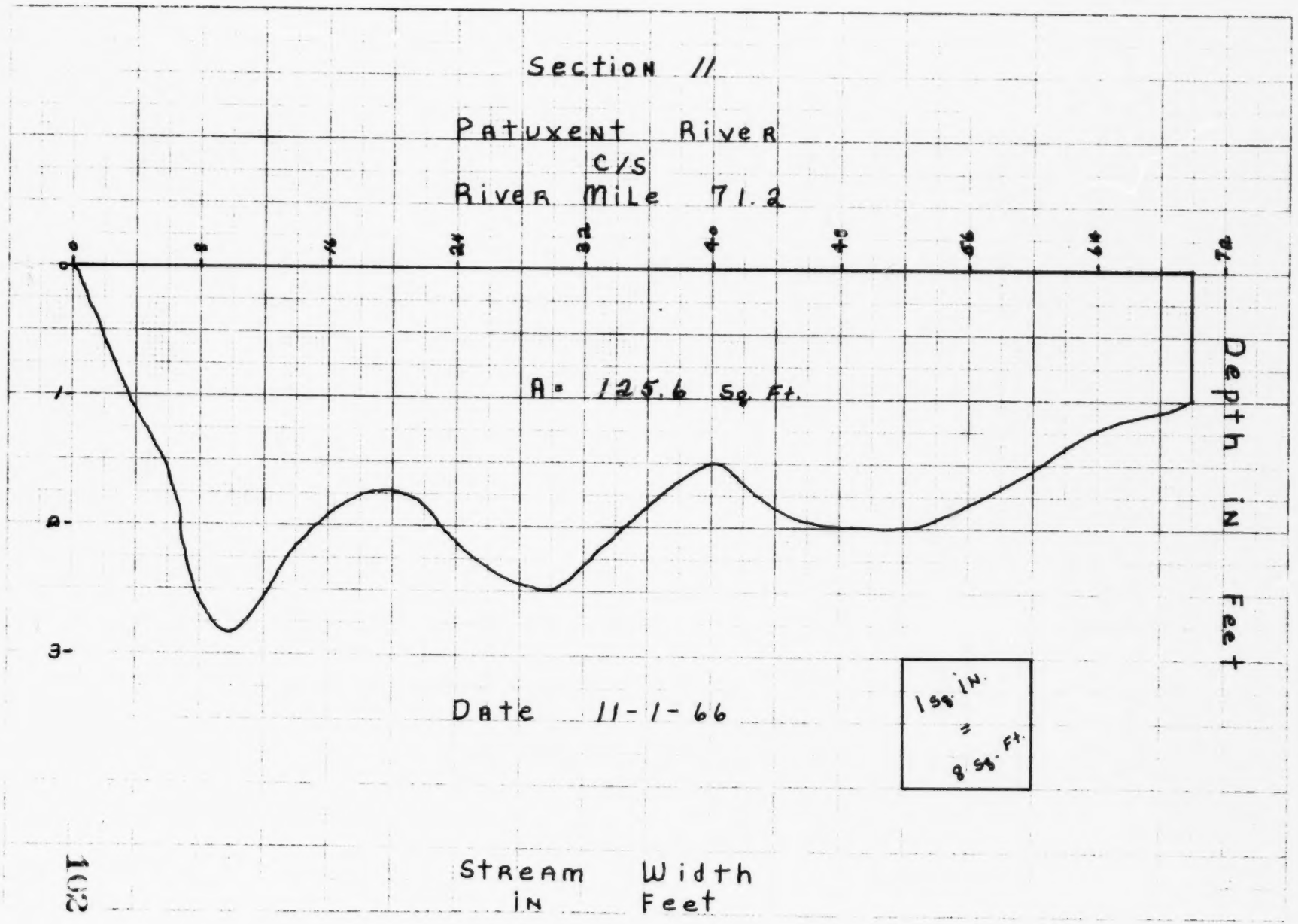

0
10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
A. 240.2 Sq. Ft.
Patuxent River C/S
River Mile 55.10
Section 5
Date 11-4-66
1 Sq. In. = 10 Sq. Ft.
Depth in Feet
Stream Width in Feet

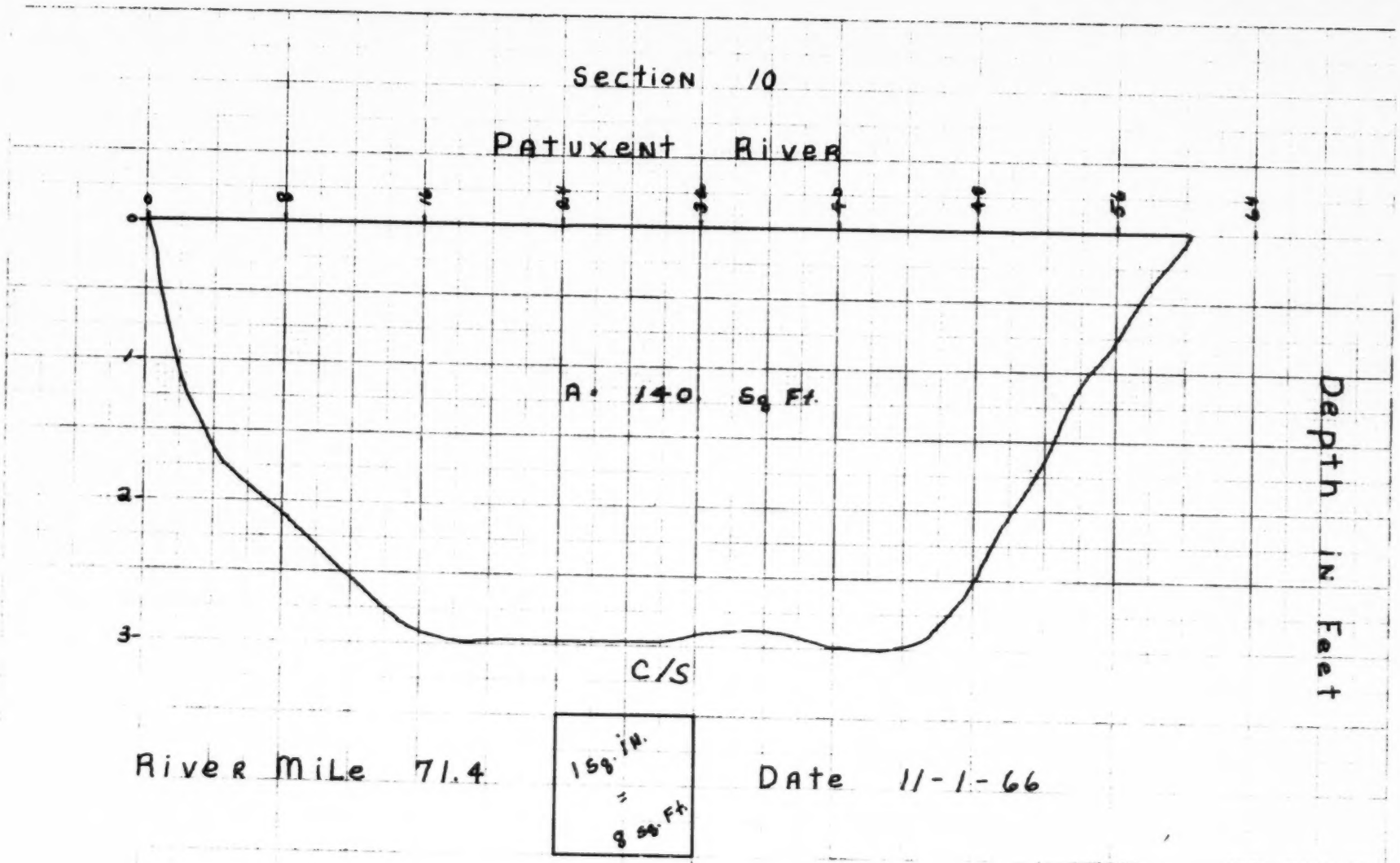

10 X 10 TO THE INCH 46 0780
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
A- 275.8 Sq Ft
Depth in Feet
Date 11-4-66
1 Sq. In. = 10 Sq. Ft.
Section 4
Patuxent River C/S
River Mile 55.32
Stream Width in Feet

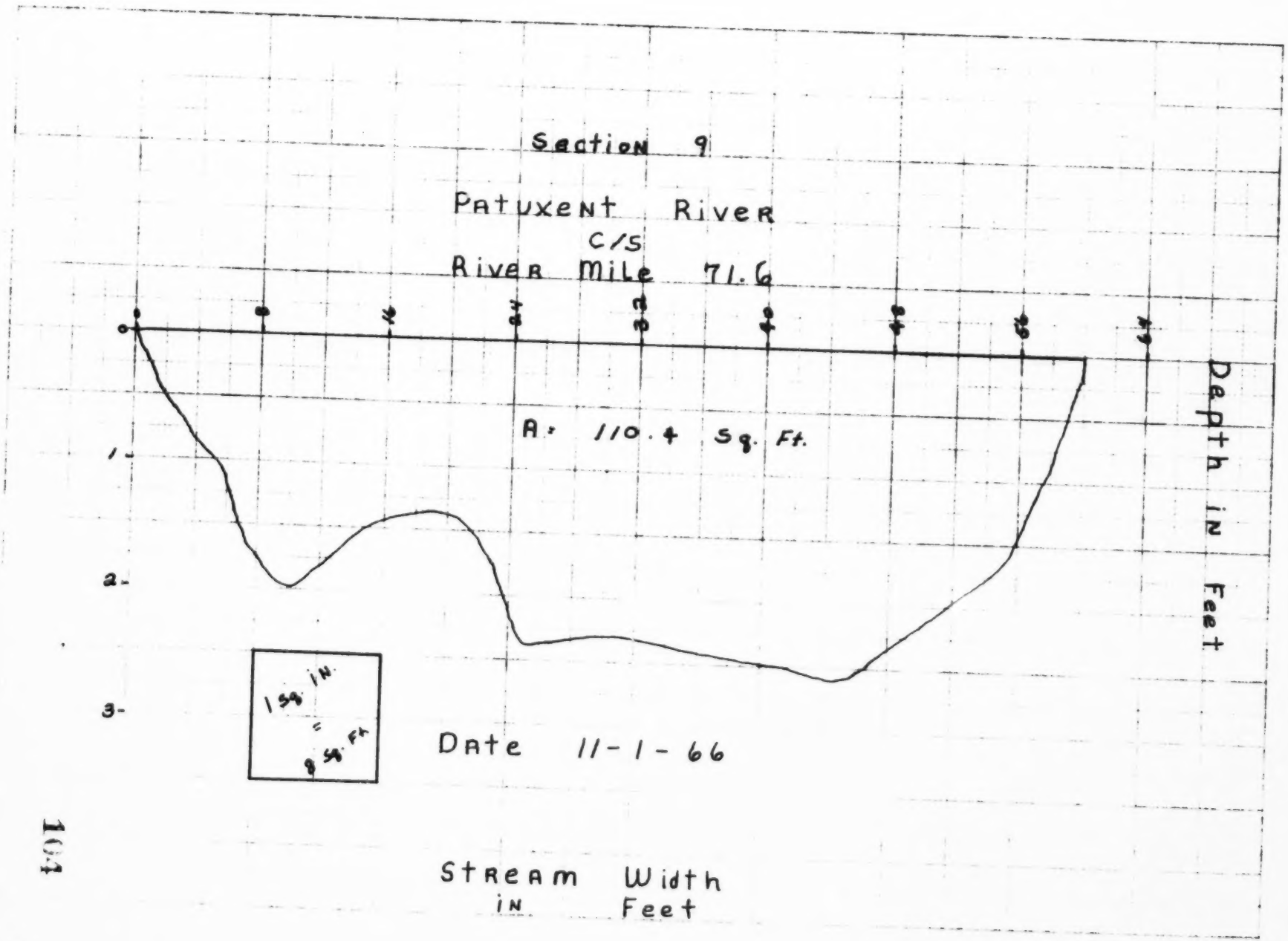

10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
A = 161.3 Sq. Ft.
Section 3
Date 11-4-66
1 Sq. in. = 10 Sq. Ft.
Depth in Feet
Patuxent River C/S
River Mile 55.54
Stream Width in Feet

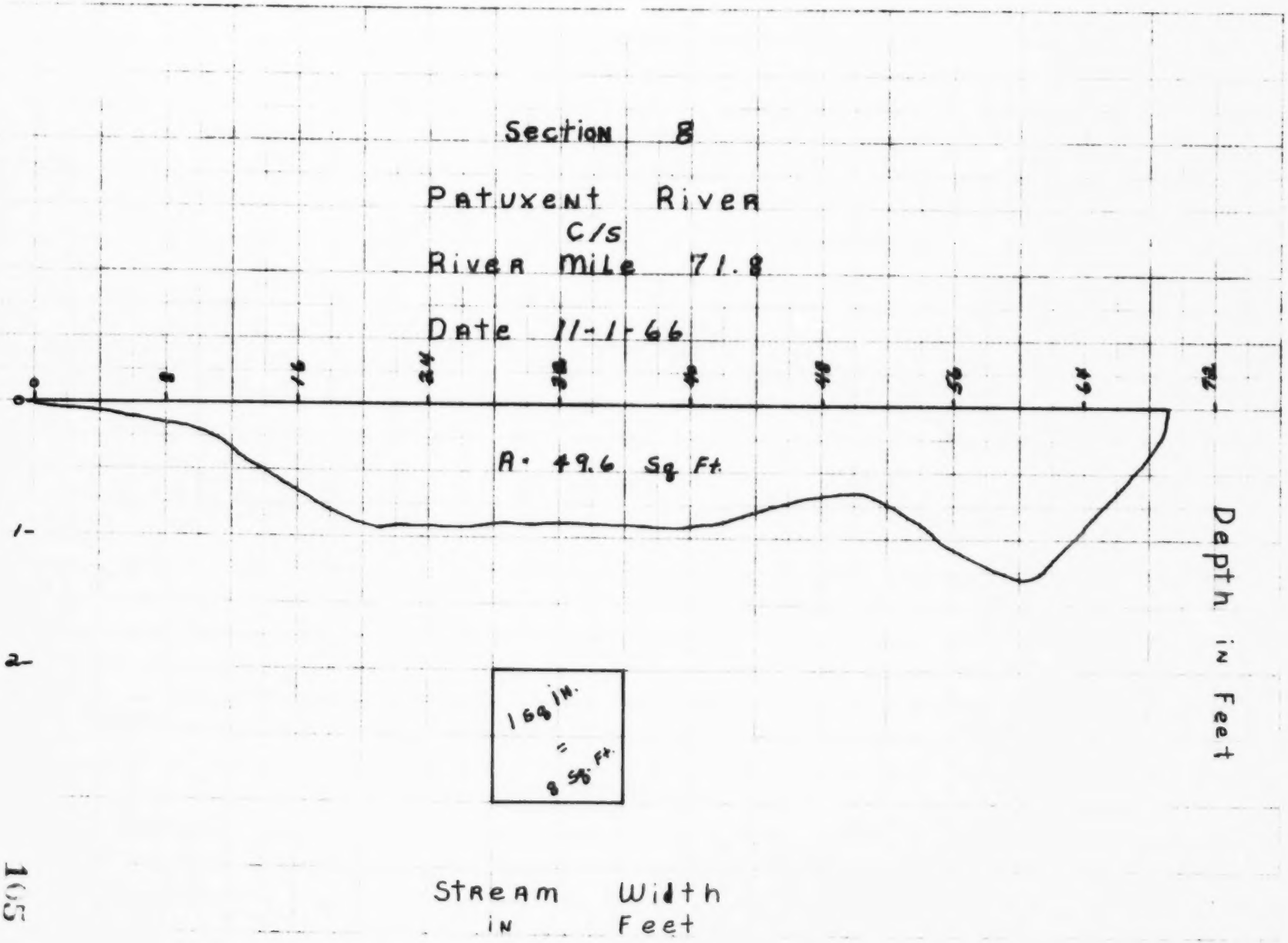

0
10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
A = 255.5 Sq. Ft.
Section 2
1 Sq. In. = 10 Sq. Ft.
Date
11-4-66
Depth in Feet
Patuxent River C/S
River Mile 55.76
100
Stream Width in Feet

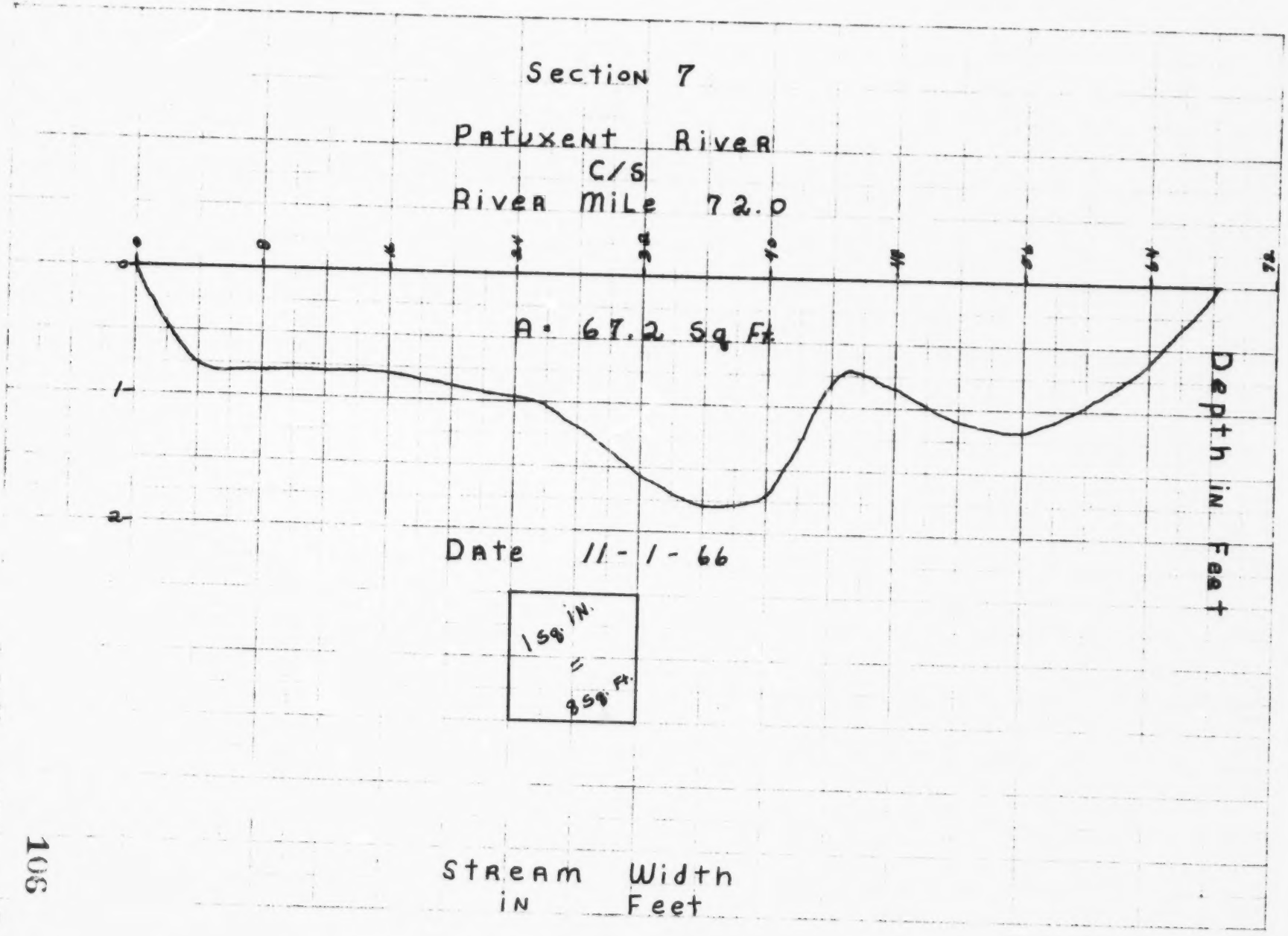

0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
5
6
7
A= 394.7 Sq. Ft.
Section 1
Patuxent River
C/S
River Mile 56.00
Date 11-4-66
1 Sq. In. = 10 Sq. Ft.
Depth in Feet
Stream
Width in Feet


Section 11
Patuxent River
C/S
River Mile 71.2
0
8
16
24
32
40
48
56
64
72
0
1
2
3
A= 125.6 Sq. Ft.
Depth in Feet
Date 11-1-66
1 Sq. in. = 8 Sq. Ft.
Stream Width in Feet


Section 10
Patuxent River
0
8
16
24
32
40
48
56
64
1
2
3
A = 140 Sq Ft.
C/S
Depth in Feet
River Mile 71.4
1 Sq. Ft. = 9.56 Sq. Ft.
Date 11-1-66
Stream Width in Feet


Section 9
Patuxent River
C/S
River Mile 71.6
0
9
24
33
44
54
59
A = 110.4 Sq. Ft.
1
2
3
1 Sq. In. = 9 Sq. Ft.
Date 11-1-66
Depth in Feet
Stream Width in Feet


Section 8
Patuxent River
C/S
River mile 71.8
Date 11-1-66
0
8
16
24
32
40
48
56
64
72
A. 49.6 Sq Ft
1
2
1 Sq IN. = 8 Sq Ft
Depth in Feet
Stream Width in Feet

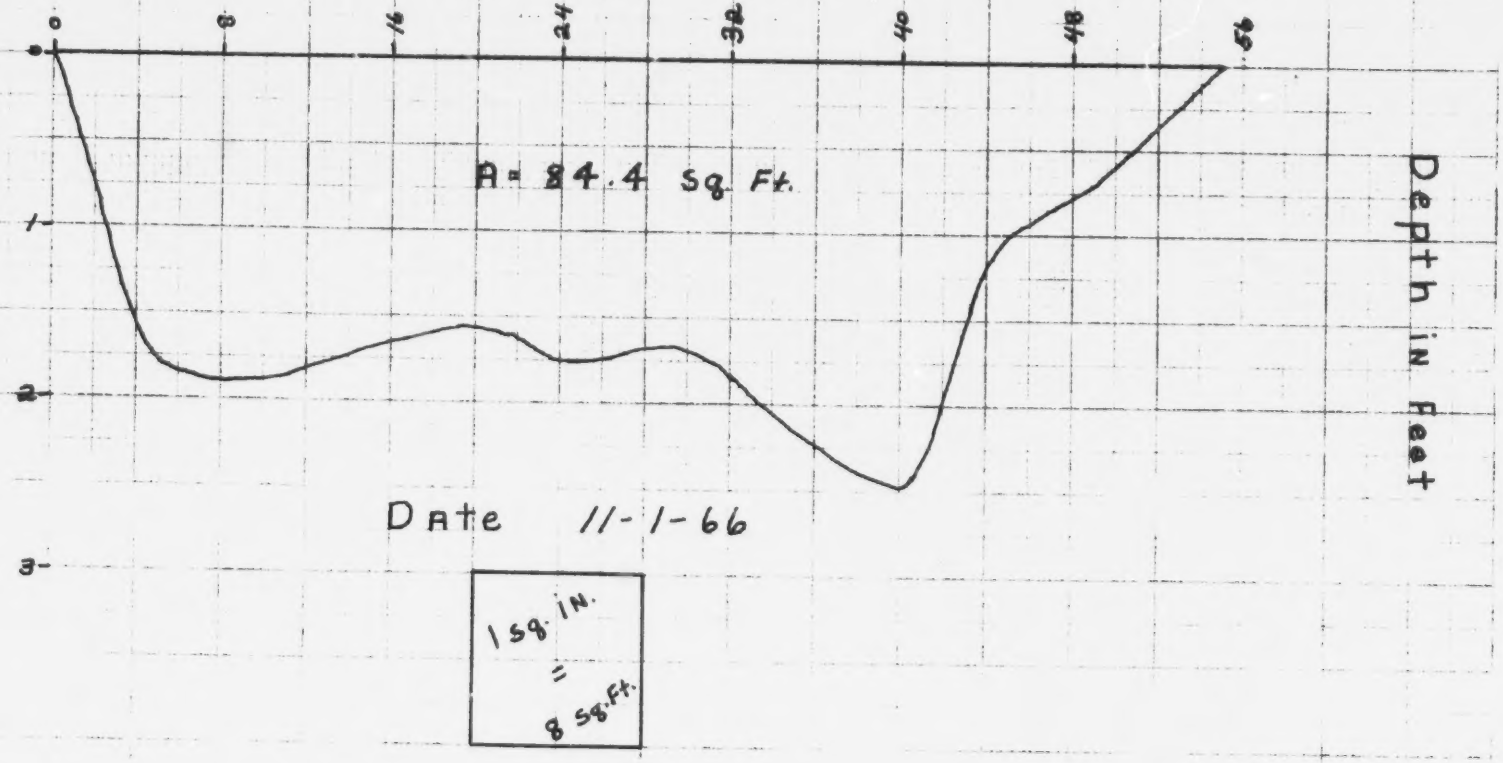

Section 7
Patuxent River
C/S
River Mile 72.0
A = 67.2 Sq Ft
Date 11-1-66
1 Sq in. = 8 Sq Ft.
Depth in Feet
Stream Width in Feet

Section 6

Patuxent River

C/S

River Mile 72.2



Date 11-1-66

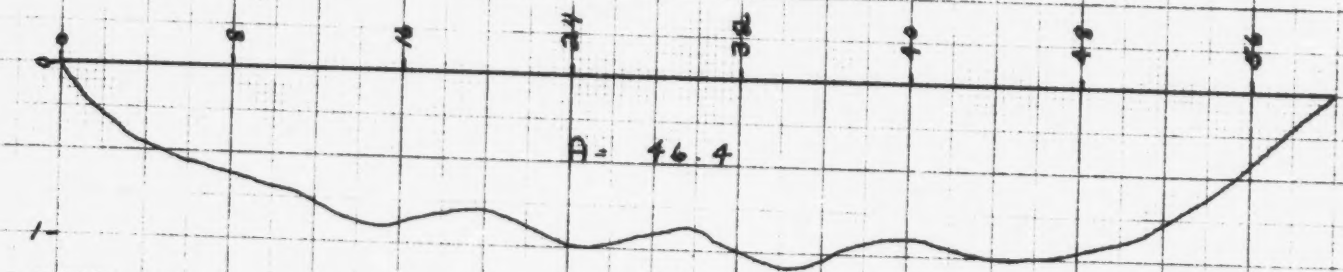
Stream Width in Feet

Section 5

Patuxent River

C/S

River Mile 72.4



Depth in Feet

Date 11-1-66

1 IN. = 8 FT.

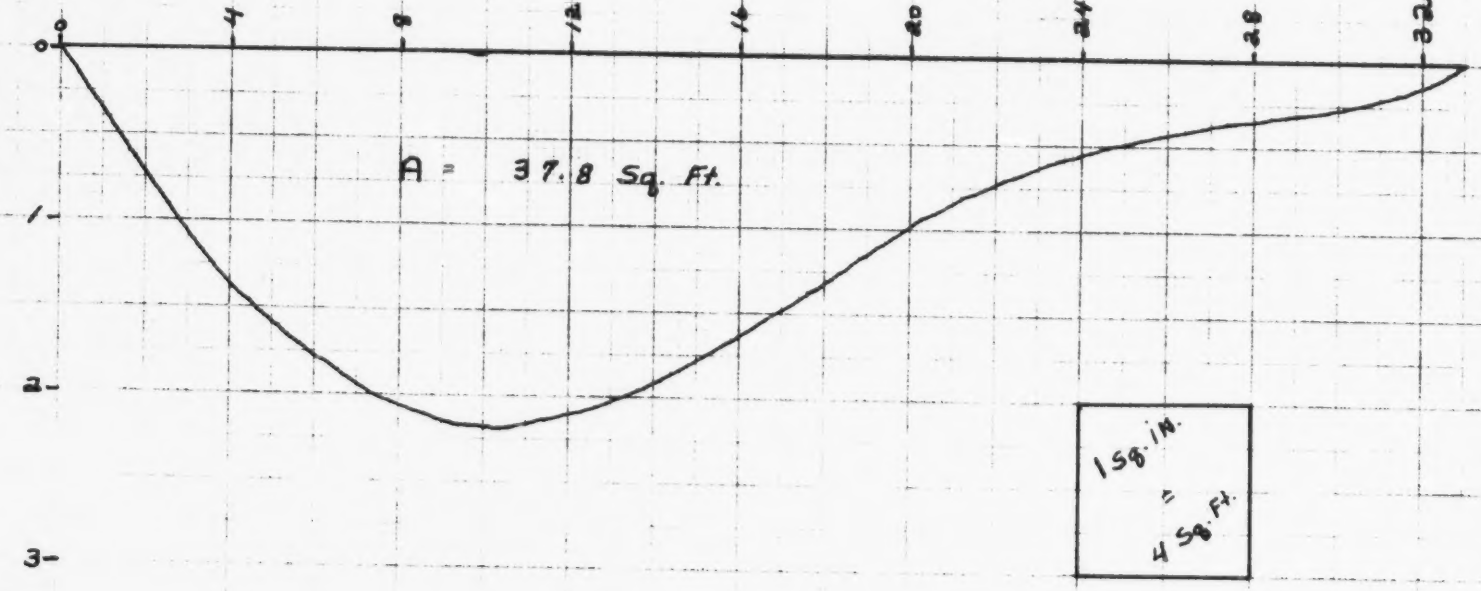
Stream Width in Feet

Section 4

Patuxent River

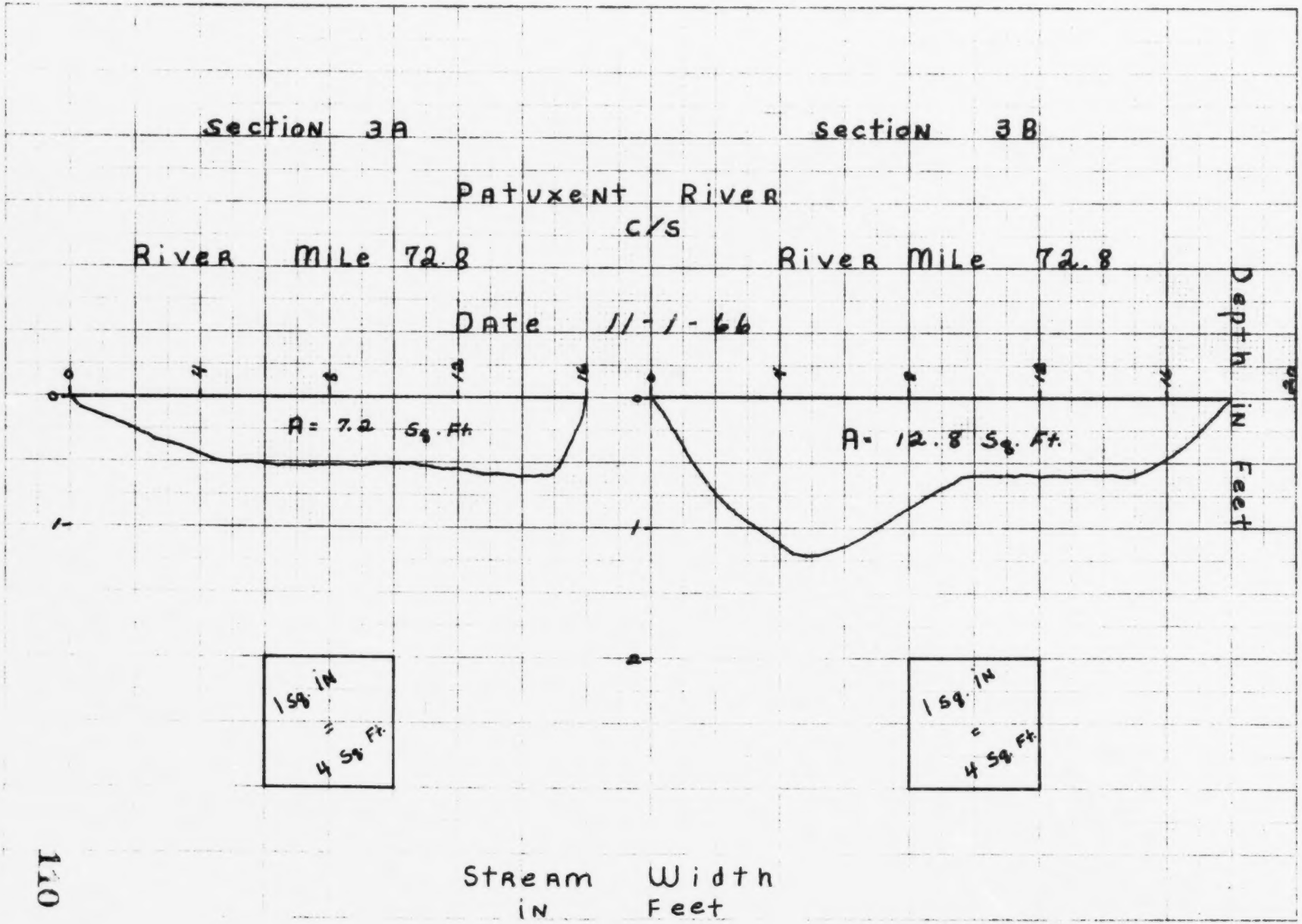
C/S

River Mile 72.6



Date 11-1-66

Stream Width in Feet


Section 3A
Section 3B
Patuxent River
C/S
River Mile 72.8
River Mile 72.8
Date 11-1-66
A= 7.2 Sq. Ft.
A= 12.8 Sq. Ft.
1 Sq. in = 4 Sq. Ft.
1 Sq. in = 4 Sq. Ft.
Depth in Feet
Stream Width in Feet

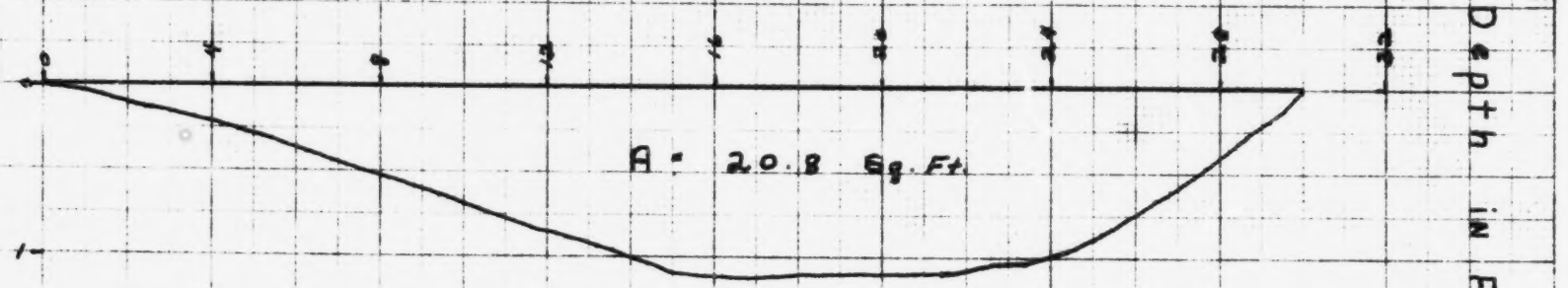
Section 3

Patuxent River

C/S

River Mile 72.8

Date 11-1-66



Depth in Feet

1 Sq. in. = 4 Sq. Ft.

Stream Width in Feet

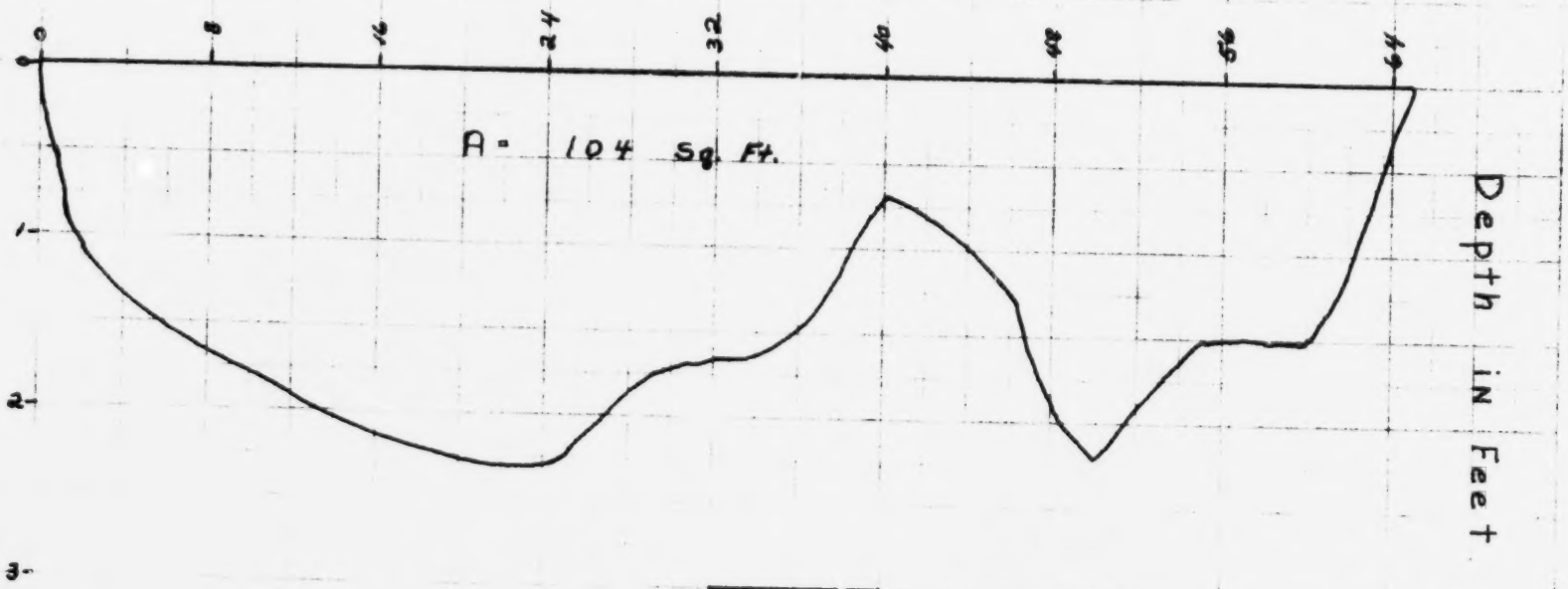
111

Section 2

Patuxent River

C/S

River Mile 73.2



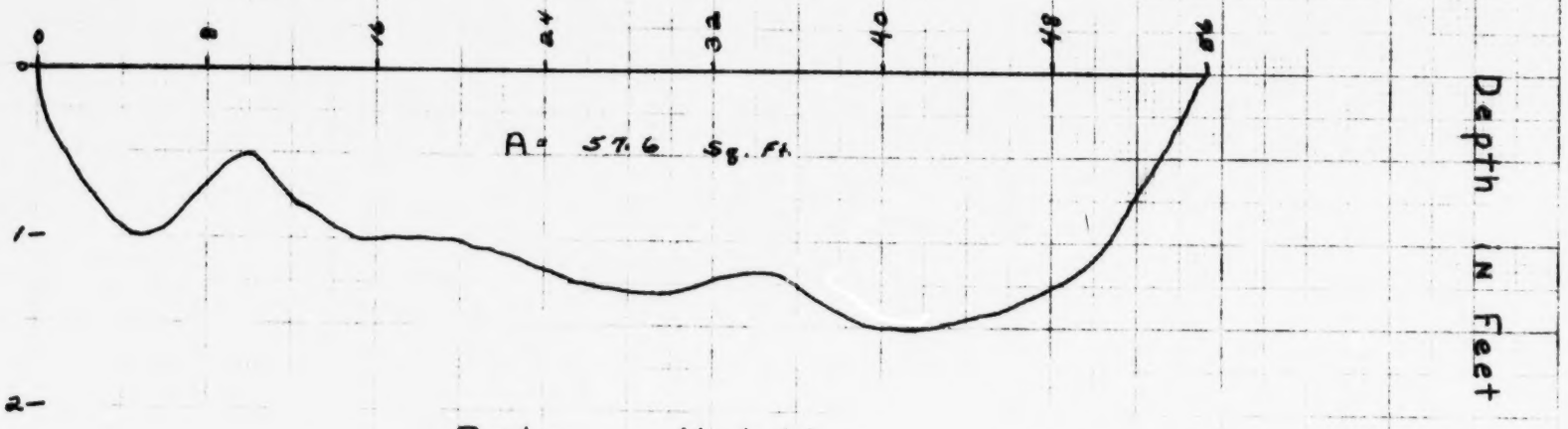
Date 11-1-66

1 Sq. In. = 8 Sq. Ft.

Stream Width in Feet

Section 1

Patuxent River
C/S
River Mile 73.4



Date 11-1-66

1 Sq. in. = 8 Sq. Ft.

Stream Width
in Feet